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Inorganic Arsenic Emissions from Primary Copper Smelters and Arsenic Plants Background Information for Promulgated Standards

(U.S.) Environmental Protection Agency
Research Triangle Park, NC

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National emission standards to control air emissions of inorganic arsenic from new and existing primary copper smelters and from arsenic trioxide and metallic arsenic production facilities are being promulgated under Section 112 of the Clean Air Act. Part I of this document contains a detailed summary of the public comments on the proposed standard for primary copper smelters (48 FR 33112), and Part II on the proposed standard for arsenic production facilities (48 FR 55880). The document also contains Agency responses to these comments and a summary of the changes made to the standards between proposal and promulgation.

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Background Information for Promulgated Standards

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

May 1986

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ENVIRONMENTAL PROTECTION AGENCY

Background Information and Final
Environmental Impact Statement
for Primary Copper Smelters
and Arsenic Plants

Prepared by:

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1. The emission standards will limit emissions of inorganic arsenic from existing and new primary copper smelters and arsenic plants. The standards implement Section 112 of the Clean Air Act and are based on the Administrator's determination of June 5, 1980 (45 FR 37886), that inorganic arsenic presents a significant risk to human health as a result of air emissions from one or more stationary source categories, and is, therefore, a hazardous air pollutant. Only one primary copper smelter, located in the State of Texas, and one arsenic plant located in Tacoma, Washington, would be affected.

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; the Council on Environmental Quality; members of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

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National Emission Standards for Hazardous Air Pollutants

PART I - NATIONAL EMISSION STANDARD FOR INORGANIC ARSENIC EMISSIONS FROM PRIMARY COPPER SMELTERS

I-1.0 SUMMARY

On July 20, 1983, the U.S. Environmental Protection Agency (EPA) proposed national emission standards (48 FR 33112) for hazardous air pollutants (NESHAP) under authority of Section 112 of the Clean Air Act (III-A-1). The standards were proposed both for primary copper smelters processing feed materials containing less than 0.7 percent arsenic (low-arsenic smelters) and for smelters processing feed materials containing 0.7 percent or greater arsenic (high-arsenic smelters). There were 19 commenters on the proposed low-arsenic standard, consisting of copper companies, environmental organizations, a trade union, two States, and several private citizens. Some of the commenters also testified at a public hearing held in Washington, D.C. The proposed high-arsenic smelter standard had nearly 700 commenters, most of whom were private citizens. Many comments also were received at public hearings in Tacoma, Washington, and Washington, D.C.

The public comment period beginning at proposal was originally scheduled to end on September 30, 1983. However, the comment period was first extended to December 10 (48 FR 38009) and then reopened until January 31, 1984 (48 FR 55880), in order to provide an opportunity for comment on modeling results being released at that time and other aspects of the rulemaking (IV-I-1, IV-I-3). After considering the comments received during this 6-month period, the Agency reconsidered the control cost and arsenic emission estimates it had made at proposal, and made several changes to these estimates based on public comments (see Sections I-4 and I-8). These revised estimates (in the form of responses to comments on the original estimates) were summarized in a memorandum dated August 31, 1984, which was placed into the docket (docket No. A-80-40) for the copper smelter arsenic standard (item No. IV-B-32). Public comments on the revised estimates were solicited in a Federal Register notice (49 FR 36877) dated September 20, 1984 (IV-I-4). Comment letters, all dated November 5, 1984, were received from three copper companies and one State environmental agency. Due to time limitations, the original responses in the response memorandum mentioned above have been retained largely in their original form for this document, with modifications as appropriate to accommodate the November comments.

At the time of proposal, the only existing high-arsenic smelter (feed material with arsenic content of 0.7 weight percent or more) was the ASARCO-Tacoma smelter. ASARCO announced on June 27, 1984, its intention to close permanently the Tacoma smelter by June 1985 (IV-D-802) and subsequently has ceased copper smelting operations at Tacoma. As a result of this development, EPA is withholding further action on the proposed regulation for existing high-arsenic copper smelters and is including in this document significant comments addressed toward high-arsenic smelters that also pertain to the remaining smelters. Comments pertaining specifically to the high-arsenic smelter category have not been included. However, material related to ASARCO's arsenic production plant at Tacoma (which will remain in operation) has also been included in this document. (Material pertaining to the arsenic plant has been designated as Part II.) The preamble to the final regulations also discusses these issues, as well as several additional aspects of EPA's regulatory policy with regard to hazardous air pollutants. Public comments and the Agency's responses served as the primary basis for the revisions made to the standard between proposal and promulgation.

I-1.1 SUMMARY OF CHANGES SINCE PROPOSAL

Several changes of varying importance have been made to the standard since proposal. The standard was changed as a result of public comments and the Agency's reanalysis of inorganic arsenic emissions, health risk, and the reasonableness of applying controls at specific smelters. Significant changes have been made, in particular, to the applicability provisions of the regulation, the opacity monitoring requirements, and the requirements for control of fugitive emissions from matte and slag tapping operations. In addition, at the suggestion of commenters, requirements for control of excess emissions during malfunctions and upsets have been added.

The standard being promulgated is applicable to new and existing primary copper smelters. The proposed standard was applicable to new and existing low-arsenic smelters, and a separate standard was proposed for high-arsenic smelters. Primary copper smelting operations were recently suspended at ASARCO's smelter at Tacoma, Washington. Since this was the only high-arsenic copper smelter, the low-arsenic smelter designation is no longer being applied to the remaining domestic smelters. These smelters will now be referred to simply as the existing primary copper smelters. The standard for converter secondary emissions now applies to all converters at a smelter where the total annual average arsenic feed rate to all converters is 75 kilograms per hour (kg/h), or greater (the cutoff at proposal was 6.5 kg/h). With these changes, it is projected that the standard will affect only one existing primary copper smelter (ASARCO's smelter in El Paso, Texas).

The standard no longer includes provisions requiring fugitive emission controls on matte and slag tapping operations. The Agency's revised arsenic emission estimates since proposal indicate that the small reduction in public health risk resulting from matte and slag tapping controls does not warrant the imposition of these controls at any of the existing smelters.

Provisions have been added to the standard requiring that steps be taken to minimize emissions during malfunctions and upsets, and requiring operation and maintenance of equipment in a manner that avoids preventable malfunctions.

The proposed standard required reporting of all 6-minute average opacity levels greater than the 97.5 percent upper confidence level of a normal or log-normal distribution of the 6-minute average opacity levels monitored during the emission test. This requirement has been revised to require establishment of reference opacity levels based on the highest 1-hour average opacity level monitored during a 36-hour evaluation period. The evaluation period will include the time period during which the emission test for the control device is conducted. Occurrences of 1-hour average opacity levels above the reference level must be reported as excess emissions.

I-1.2 SUMMARY OF IMPACTS OF THE PROMULGATED ACTION

I-1.2.1 Alternatives to Promulgated Action

Regulatory alternatives were presented in two documents released at proposal. Alternatives for high-arsenic copper smelters were discussed in Section 4 of background information document EPA-450/3-83-009a (hereinafter referred to as the high-arsenic BID, Volume I, item III-B-1 in docket No. A-80-40). Alternatives for low-arsenic smelters were discussed in Section 4 of EPA-450/3-83-010a (low-arsenic BID, Volume I, III-B-2). The regulatory alternatives for both source categories were also covered in the preambles to the proposed standards (48 FR 33112). These alternatives remain the same.

1.2.2 Environmental and Health Impacts of Promulgated Action

The final standard affects existing and any new primary copper smelters. The EPA projects that the standard will affect only one existing domestic copper smelter, and that no new domestic copper smelters will be constructed in the next 5 years.

The standard will reduce secondary inorganic arsenic emissions from the affected smelter by about 1 to 4 megagrams (Mg) per year (1.1 to 4.4 tons per year). As a result of this emission reduction, EPA estimates that the number of incidences per year of lung cancer due to inorganic arsenic exposure for persons residing within 50 kilometers (31 miles) of the affected smelter will be reduced from 0.38 to 0.29 case per year. The standard will reduce the estimated maximum lifetime risk from exposure to airborne inorganic arsenic near the affected smelter from (1×10^{-3}) to (8×10^{-4}). These estimated health impacts are based on a number of assumptions and contain considerable uncertainty. Appendix C of this document discusses the health impact calculations further.

Application of the required controls (air curtain secondary hoods on converters) will increase slightly the amount of solid waste to be handled by the affected smelter. This solid waste will consist of additional dust collected by the currently operated baghouse. The additional baghouse catch of 3.6 Mg/yr of arsenic, or 18 Mg/yr of total dust, will increase the amount collected by the baghouse by only about 5 percent. This added dust can be handled easily by the smelter and will not produce any significant environmental impact. No direct water pollution impact is created by the standard, because the baghouse collecting converter secondary emissions at the affected smelter is a dry collection system.

1.2.3 Energy and Economic Impacts of Promulgated Action

The standard will increase electrical power consumption at the affected smelter by approximately 2,000 MW, or 0.1 percent above current plant energy requirements.

The capital and annualized costs of complying with the standard are estimated to be about $1.85 million and $379,000 per year, respectively.

The primary economic impact associated with the standard is a projected decrease in profitability for the affected smelter if costs cannot be passed through in the form of product price increases. It is estimated that if control costs are passed through, the standard will result in a 0.2 to 0.3 percent increase in the price of copper (see Appendix F). No plant closures are anticipated as a result of the regulation.

I-2.0 GENERAL COMMENTS ON THE PROPOSED STANDARD

I-2.1 GENERAL OPINIONS IN FAVOR OF THE PROPOSED STANDARD

Comment: Tennessee Chemical Company expressed agreement and support for the proposed standard, referring to the "non impact" of its Copperhill, Tennessee copper smelter. (Tennessee Chemical-Copperhill fell well below the cutoffs for applicability in the proposal.) (IV-D-140). Magma Copper Company similarly stated its agreement with EPA's finding in the proposal that the existing furnace controls at Magma's San Manuel smelter constitute best available technology (BAT), and that additional fugitive emission controls would not be cost effective (IV-D-619). The State of Washington Department of Ecology concurred with EPA's determination that the "very small emitters" among the low-arsenic copper smelters should be excluded from BAT requirements (IV-D-622).

Response: No response necessary.

I-2.2 DISTINCTION BETWEEN HIGH- AND LOW-ARSENIC COPPER SMELTER CATEGORIES

Comment: One commenter noted that no rationale or explanation has been presented for how EPA selected the cutoff used at proposal to differentiate between high- and low-arsenic throughput smelters (IV-F-4).

Response: As discussed in the Federal Register notice of proposed rulemaking (48 FR 33112), EPA separated the primary copper smelting industry into two source categories based on the annual average inorganic arsenic content of the smelter feed material. From information provided by the copper smelting industry, EPA determined that the arsenic content of the feed processed by the ASARCO-Tacoma smelter was an order of magnitude greater than that for the other 14 primary copper smelters located in the United States. Typically, feed material containing on the average 4.0 weight percent inorganic arsenic was processed at the ASARCO-Tacoma smelter at a rate of 940 kilograms of inorganic arsenic per hour (kg/h). The second highest average inorganic arsenic content in the feed material processed at a domestic smelter is 0.5 weight percent, while the second highest average process rate of inorganic arsenic is approximately 265 kg/h. In addition, unlike at the other 14 smelters, arsenic is processed in an arsenic production plant at the ASARCO-Tacoma smelter and sold for commercial use.

The EPA believes it was reasonable at proposal for purposes of regulation to separate smelters into two source categories based on the annual average inorganic arsenic content in the feed because of the potential for significantly higher inorganic arsenic emissions from the ASARCO-Tacoma smelter than from other smelters. Consequently, the benefits associated with the application of specific control technologies to the ASARCO-Tacoma smelter versus other smelters would be significantly different when considered in terms of emission and risk reduction, costs, and energy and other impacts. Of course, since ASARCO has recently closed copper smelting operations at Tacoma, all existing primary copper smelters are now in the same category and the distinction based on arsenic input is no longer necessary. Further, as discussed in Section I-2.3, EPA projects that no new domestic smelters will be constructed in the next 5 years. Therefore, the commenter's concern is no longer pertinent since all smelters at this time and in the foreseeable future will be regulated on a common basis and in a single source category.

I-2.3 NEW HIGH-ARSENIC COPPER SMELTERS

Comment: The Friends of the Earth commented that no reason was given in the Federal Register notice of proposed rulemaking or the background information documents as to why EPA believed that new smelters using high-arsenic feed material would not be built (IV-D-609).

Response: The Federal Register notice of proposed rulemaking states that EPA projected that no new domestic primary copper smelters would be built during the next 5 years (48 FR 33124). This projection is based on EPA's conclusion that annual copper industry growth in the United States will be accommodated by existing primary copper smelting capacity. Neglecting the low copper production in 1980 as a result of a smelter worker strike and in 1982 as a result of a recession, total copper production in the United States has averaged 1,380 gigagrams per year (Gg/yr) since 1977. Current primary copper smelting capacity in the United States is about 1,632 Gg/yr.* The net effect of potential shutdowns and smelter expansions on total capacity by 1988 is estimated to be a decline in capacity to 1,435 Gg/yr. However, the increase in utilization to a 90 percent rate is not expected to require new capacity based on the lack of long-term growth in smelter production over recent years. Thus, EPA does not expect any new primary copper smelter processing either high-arsenic or low-arsenic feed to be constructed in the United States during the next 5 years.

If a new primary copper smelter processing high-arsenic feed is built, the promulgated standard will apply to that smelter. However, to estimate the potential impacts and benefits of the standard, it is necessary to rely on reasonable projections of possible new construction. Since it was EPA's best projection that no new primary copper smelters would be built, EPA's analysis at proposal was based on application of controls to the existing high-and low-arsenic domestic copper smelters.

I-2.4 APPLICABILITY OF THE STANDARD

Comment: Phelps Dodge requested confirmation of its interpretation of the proposed procedure for determining the applicability of the standard to particular low-arsenic copper smelters. As stated in their comments, "It is the understanding of Phelps Dodge that no smelter will be required to install horizontal air curtain secondary hoods over copper converters so long as the converter arsenic charging rate is less than 6.5 kg/h averaged over a 1-year period (§61.172(c)). This annual arsenic charging rate will be determined for each copper converter once per month by computing the arithmetic average of the 12 converter arsenic charging rate values for the preceding 12-month period (§61.175 (d)(4)). Thus, after these regulations become effective, no copper smelter will have an established "annual arsenic charging rate" for its converters until 1 full year after the proposed regulations become effective. One year after the regulations become effective, some smelters will undoubtedly be above the 6.5 kg/h standard while others will be below that regulatory limit. Those smelters above the regulatory limit will have the right to apply for a 2-year waiver from compliance pursuant to 42 U.S.C. §7412(c)(B)(ii) and 40 CFR §61.173(a)(1). See also, 48 FR 33122. If at any time during the 2-year waiver period the annual arsenic charging rate falls below (and stays below) the regulatory limit, the smelter will not be required to install horizontal air curtain secondary hoods" [footnote omitted] (IV-D-640).

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*Information for 1982 as reported in Table 2-1 of the proposal BID's, subtracting the capacity figure for ASARCO-Tacoma.

Response: The proposed regulation may not have been clear in expressing EPA's intent concerning the determination of applicability of some provisions of the standard to primary copper smelters. In proposed §61.172(c), the cutoff converter arsenic charging rate of 6.5 kg/h appeared to apply to each copper converter at a facility. The intention, however, was to apply this cutoff figure to the total arsenic charging rate for all of the converters at a smelter (the "copper converter department"). Since proposal, the charging rate cutoff has been increased from 6.5 to 75 kg/h (§61.172(a) of the final standard). To determine this total charging rate, §61.174(f) specifies that the individual computed charging rates be added together monthly to obtain the rate for the entire converter department, and a running annual average will be calculated using the previous 12 monthly values.

Another area of the proposed standard that may have created confusion concerned the requirement in proposed §61.173(a)(1) for owners and operators to install capture equipment no later than 90 days after the effective (promulgation) date of the regulation, unless a waiver of compliance was approved by the Administrator. This requirement reflects the intention of Section 112(c)(1)(B)(i) of the Act, and is retained in the final standard. Confusion may have arisen because of the additional provision in §61.172(c) [final §61.172(a)] for a 1-year period during which sampling of the converter charge is conducted to determine an average arsenic charging rate for comparison to the regulatory cutoff. This requirement for sampling, while intended to apply to all primary copper smelters, is particularly oriented toward those smelters that past sampling determinations show to be operating quite near to the cutoff figure, or whose projections indicate may increase their converter arsenic charging rate in the future. Those smelters whose historical data show to be well above or well below the cutoff, and which do not project any significant change in operations in the foreseeable future, were expected to recognize their possible applicability status at promulgation without waiting for the results of the one-year sampling program. Smelters with high converter arsenic charging rates should have prepared to initiate compliance measures when the standard was promulgated in order to achieve compliance within 90 days of the effective date. The waiver referred to under §61.175(a)(4) [final §61.174(a)(4)] is intended to apply to facilities that cannot be brought into compliance within the initial 90-day period following the effective date. Owners and operators of sources covered under the standard, who require more than 90 days to bring their sources into compliance, should apply for a waiver of up to 2 years at the time the standard is promulgated.

To summarize, any facility indicated by historical sampling data to process arsenic through its converters at rates well in excess of the final regulatory cutoff is presumed by the Agency to be subject to the control requirements on converter secondary emissions, and is expected to take steps, beginning on the effective date, to implement these requirements for its converters.

I-2.5 APPLICABILITY BASED ON CONVERTER CHARGING RATE

Comment: ASARCO felt there was no reasonable basis for establishing a cutoff value for determining the applicability of converter controls in terms of the converter arsenic charging rate. Instead of exempting converters that are charged at less than 6.5 kg/h, as proposed in §61.172(c), the cutoff should be set at 6.5 kg/h of estimated converter baseline fugitive emissions. The proposed cutoff imposes control costs far beyond those that can be considered reasonable (IV-D-620).

Response: As explained in the proposal notice (48 FR 33143), the Agency considered emission rates, emission reduction potential, control costs, and the expected economic impacts of controls on individual smelters in establishing the reasonableness of requiring controls on converter operations. These elements in actuality formed the basis for the division between smelters for which secondary converter controls were reasonable and those for which they were not. An objective, readily determinable parameter was sought to permit the two groups of low-arsenic smelters, already established using the criteria mentioned above, to be distinguished from one another. The parameter of arsenic charging rate to the converters was selected because it can be computed readily from the arsenic concentration in the matte and the total matte charging rate to the converters, parameters that can be measured directly. Further, a smelter may be able to use ores with lower arsenic content to lower its arsenic charging rate.

Since proposal, EPA has evaluated the health risks presented by each primary copper smelter in light of the revised arsenic emission estimates calculated since proposal (see Section I-4). Based on this analysis, EPA revised the cutoff to distinguish between primary copper smelters where additional emission control is reasonable and those where additional emission control imposes costs that far exceed any public health benefit. The cutoff has been changed from the proposed converter arsenic charging rate of 6.5 kg/h to a final rate of 75 kg/h to reflect this policy.

The EPA considered the commenter's suggestion to change the cutoff to 6.5 kg/h of estimated converter baseline fugitive emissions. This cutoff rate is equivalent to an emission rate of about 56 Mg/yr; since the highest estimated value in Table III-1 of the preamble to the promulgated standards is 13.3 Mg/yr, no smelter would be covered by converter control requirements under the suggested approach. This result is not consistent with the findings of EPA's health risk analysis or with EPA's stated purpose for the cutoff. Therefore, EPA did not incorporate the commenter's suggestion.

I-2.6 PUBLIC HEARINGS

Comment: Several commenters felt that public hearings on the proposed standards should have been held in areas at risk from copper smelter arsenic emissions, and particularly in Arizona, where seven of the smelters are located (IV-D-151, -224, -241, -301, -346, -549, -573, -608, -795; IV-F-1, IV-F-2, IV-H-4, IV-H-7).

Response: Public hearings on the proposed NESHAP were originally scheduled in the proposal notice to be held on August 23, 24, and 25, 1983 (Washington, D.C.), and August 30, 1983 (Tacoma, Washington), to provide interested parties the opportunity to comment on the proposal in person (III-A-1). At the request of several commenters who needed more time to prepare for the hearings, the Tacoma hearing was postponed until November 2, 3, and 4, 1983, and the Washington, D.C., hearing until November 8, 1983 (IV-I-1). Limitations of time and resources prevented the Agency from conducting any additional hearings.

The public comment period allowed anyone who could not be present at the hearings an opportunity to comment on an equal basis with the participants at the hearings. The comment period, originally scheduled to end on September 30, 1983, was first extended to December 10 and then reopened until January 31, 1984 (IV-I-1, IV-I-3). It was again reopened on September 20, 1984 (IV-I-4), in order to receive public comments on EPA's preliminary revisions to the arsenic emission estimates and control costs presented at proposal. Written comments submitted during these periods were given the same level of consideration in finalizing the regulation as those presented at the hearings.

I-2.7 REQUESTS FOR TECHNICAL ASSISTANCE

Comment: The Natural Resources Defense Council (NRDC) questioned the sincerity of the Agency's commitment to public involvement in the regulatory development process because EPA had turned down requests for technical assistance from both local and national environmental groups (IV-F-1, IV-F-2).

Response: This environmental organization requested in a letter to the Administrator that access to EPA contractor time be granted to assist them in reviewing the background information pertaining in particular to the low-arsenic copper smelters and the other industries considered in the proposal. In the same letter, a postponement of the public hearings was requested (IV-D-119).

In response to these requests (IV-C-48), EPA re-emphasized its commitment to providing as much relevant information as possible to the citizens who are interested in and affected by this rulemaking. However, the Agency expressed its view that the loan of contractor support to any group or coalition of groups could potentially generate controversy, since it would be difficult to assure equal treatment and fairness to the various perspectives of the affected parties. For this reason, direct contractual assistance was not provided to any of the parties that requested it. However, EPA pointed out that the findings of the consultants would be made available as they were developed. Further, it was noted that the Agency would investigate questions and issues raised by NRDC and others, and in this way would address the concerns expressed by NRDC. The commenter was referred to the Puget Sound Air Pollution Control Agency (PSAPCA) as an information source on smelter control techniques (in particular regarding the ASARCO-Tacoma high-arsenic smelter), which was available to represent the perspectives and interests of the citizens of the area. Finally, several docket materials were sent to the commenter at its request (IV-C-3).

As pointed out in Section I-2.6, the public hearings were rescheduled and the comment period was extended and reopened to accommodate the requests of commenters and to allow the maximum possible public involvement.

I-2.8 OPPORTUNITY FOR COMMENT ON NEW DOCKET ADDITIONS

Comment: Kennecott felt that the public should be given an opportunity to comment on any new information and data added to the docket between proposal and promulgation of the standard. The commenter was concerned that insufficient review time would be available for the later docket entries, and they referred to previous instances of court censure when docket items were entered immediately prior to promulgation (IV-D-634). ASARCO and Kennecott commented, in response to EPA's memorandum containing revised arsenic emission and control cost estimates (IV-B-32), that if risk estimates for copper smelters are revised between proposal and promulgation they should be presented for public comment before a final regulation is issued (IV-D-811, IV-D-812).

Response: The EPA's regulatory development procedure is to propose standards after an open development period in which participation by all interested parties is encouraged. All information considered in the development of the standards, up until standards are promulgated, is placed into the docket as quickly as it can be indexed, copied, and distributed to the docket locations. The Agency realizes that occasionally certain items of information are unavoidably added quite close to the promulgation date.

In this rulemaking, a particular effort has been made to enter docket materials as soon as possible after they became available. While all nonconfidential docket materials are available for public review, including copying privileges, time constraints generally do not allow a formal public review and comment period for materials added to the docket between proposal and promulgation. (However, revised emission and cost estimates were placed in the docket for public review, and announced by a Federal Register notice, after the general comment period had ended; see Section I-1.0). The Agency's risk estimates were constantly revised and updated during this period as revisions were made to arsenic emission estimates and other modeling input parameters. It was not possible, within the time constraints of the regulatory development schedule, to allow an additional formal public review and comment period for these risk estimates. However, the revised risk estimates were placed in the docket and also were sent directly to ASARCO, Kennecott, Phelps Dodge, and NRDC for their review before the standard was promulgated.

I-2.9 ENFORCEMENT AND REPORTING OF VIOLATIONS

Comment: The Sierra Club, Grand Canyon Chapter, felt that "stiff penalties" should be assessed for violations of the provisions of the standards. Also, violations should be reported by the companies at the time the violations occur, instead of in the semiannual reports to the Agency required under §61.178(b) and (c) (IV-D-608).

Response: The Clean Air Act (42 U.S.C. 7411) as amended, establishes a mechanism for the Agency to determine the compliance status of an emission source subject to the provisions of Section 112, and to assess appropriate penalties against an owner or operator whose source is found to be in violation of this Section's emission standards.

Under Section 114(a)(1), the Administrator may require an owner or operator to maintain records of monitoring and sampling, and to make this and any other pertinent information available to the Agency as reasonably required to permit a determination of the compliance status of the source to be made.

Section 120 requires the Administrator (or the State in cases where the authority has been delegated) to assess and collect a noncompliance penalty against owners and operators of stationary sources that are in violation of the requirements of Section 112. Section 120(d)(2) sets the amount of the penalty, which must be no less than the net economic benefit accruing to an owner as a direct result of his failure to comply with these requirements. Finally, Section 120(d)(5) sets a nonpayment penalty for each quarter during which failure to pay a noncompliance penalty occurs. The Administrator is granted the discretion, in Section 120(a)(1)(c), to exempt any source found to be out of compliance from assessment of penalty if the violation is determined to be of a minor nature. The opportunity for public hearing is a part of this determination process. The EPA believes that this regulatory mechanism, which provides EPA the authority to collect information that will allow compliance determinations and to impose penalties that destroy the financial incentive to pollute, is adequate for encouraging sources to comply with the standard.

The proposed standard required a semiannual written report to the Administrator describing any occurrences of excess opacity or low air flow rates through the air curtain system. Reporting requirements, in general, assist the Agency in the enforcement of emission standards by providing information concerning the operating level of control equipment. The EPA considered the suggestion to require reports of violations as they occur, and concluded that the benefits of reporting at this frequency would be outweighed by the burden created for owners and operators by the increased paperwork. The reporting frequency required in the final regulation (§61.177(c)(3) and (d)(2)) has been increased, however, to quarterly reporting. The Agency believes that this represents a reasonable reporting period that will not create excessive paperwork for smelter owners and operators.

I-3.0 LEGAL AND POLICY ISSUES

I-3.1 REQUIREMENTS OF SECTION 112 OF THE CLEAN AIR ACT

Comment: The New York State Department of Law and the State of New Mexico commented that EPA has violated Section 112 of the Clean Air Act requirements by not setting emission standards and by failing to demonstrate that emission standards are infeasible (IV-D-698, IV-D-810).

Response: Section 112 of the Clean Air Act states that national emission standards must, whenever possible, take the format of a numerical emission limit. Section 112(e)(2) recognizes that in certain instances, numerical emission limits are not possible: (1) when the pollutants cannot be emitted through a conveyance designed and constructed to emit or capture the pollutant, and (2) when the application of a measurement methodology is not practicable due to technological limitations. In such instances, Section 112(e)(1) authorizes design, equipment, work practice, or operational standards.

In developing the standard for secondary inorganic arsenic emissions from converter operations, EPA considered separately the format of standards for the capture and collection of emissions. For the collection of emissions, EPA set a numerical emission limit because it was feasible. However, EPA determined that a numerical emission limit for the capture of secondary inorganic arsenic emissions from converter operations is not feasible because neither the capture efficiency nor the quantity of emissions that escape capture by secondary control techniques can be measured accurately by source testing or quantified by visual observation techniques (e.g., EPA Reference Method 9 or 22). In this situation, equipment, work practice, and operational standards are necessary to assure effective control. Therefore, the final regulation specifies these types of formats to effect capture of converter secondary arsenic emissions.

I-3.2 SELECTION OF BEST EMISSION CONTROLS

Comment: The Chemical Manufacturers Association commented that when EPA selects BAT for a source category, the Agency should consider only those control technologies that have been adequately demonstrated on commercial-scale plants of the type that would be subject to the control requirements. The commenter argued that when control technologies have not been demonstrated on the particular type of source in question, judgments on emission reductions achievable will be speculative and unreliable (IV-D-617).

Response: The policy set forth in the Federal Register notice of proposed rulemaking (48 FR 33116) can be paraphrased as follows: It is EPA's judgment that the best interpretation of Section 112 for non-threshold pollutants is to establish standards that would control a source category at least to the level that reflects best available technology (BAT), and to a more stringent level if it is necessary to prevent unreasonable risks. By BAT, EPA means the best adequately demonstrated controls available considering economic, energy, and environmental impacts. Whether the estimated risks remaining after application of BAT are reasonable is decided in light of the Administrator's judgmental evaluation of the estimated maximum lifetime risk and cancer incidences per year remaining after application of BAT; the impacts, including economic impacts, of further reducing those risks; the readily available benefits of the substance or activity producing the risk; and the availability of substitutes and possible health effects resulting from their use.

Since proposal, EPA has eliminated the term "BAT" from this rulemaking and redirected certain aspects of its technology selection and application policies under Section 112.

The EPA's standard setting policy for carcinogens regulated under Section 112 of the Clean Air Act provides for consideration of the risks, costs, and potential benefits of various levels of control. Under this policy, it is not necessary that control technology be fully demonstrated in order to serve as the basis for the standard. However, the extent to which a technology has been demonstrated and any uncertainty as to whether it could be effectively applied to a prospective source category are considered. In practice, EPA would consider control technology to be demonstrated if it could be shown to be demonstrated for a similar source category, but not necessarily for the source category being regulated. This means that a system used in an entirely different industry using a different process from the one being regulated could be considered best emission control if its performance were judged to be unaffected by the differences in the processes. Similarly, a system used in some segments of the industry being regulated, or in some parts of the process, but not in others, can be considered best control for all segments or all parts of the process if investigation of the relevant variables reveals no reason that it could not be designed, installed, and operated so that it achieved the same emission control under all the conditions in which it would be applied.

In the case of primary copper smelters, the standard requires the use of emission capture and control equipment that has been used in the affected industry. Hence, the commenter's concerns are not pertinent to this standard.

I-3.3 RELIANCE ON OTHER STANDARDS TO ACHIEVE CONTROL

Comment: The NRDC and the States of New York and New Mexico felt that it was inadequate for EPA to rely on control measures currently in place, or scheduled to become effective pursuant to SIP's, judicial consent decrees, or OSHA standards, as a substitute for Section 112 standards. In the preamble to the proposed standard for primary copper smelters, EPA concluded that various existing or planned control measures at several smelters constituted best emission control on inorganic arsenic emissions. In these instances, the Agency concluded that further control measures under Section 112 were not necessary.

The commenters believe that the requirements of SIP's and consent decrees do not satisfy the mandate of Section 112 for several reasons. These other requirements are written in response to Section 110, which imposes different responsibilities on the Agency than Section 112.

These standards are oriented toward particulate matter and SO_2 (not arsenic), they impose selective controls that may be relaxed in response to improving air quality, and they often suffer from uncertainty about future compliance.

OSHA standards take the form of an indoor worker exposure limit, and so captured emissions are often vented directly to the atmosphere. These standards also undergo long delays before they are implemented, may be changed without reference to Section 112, and contain no provisions for citizen suit enforcement.

In cases where EPA has validly determined that these other types of requirements are appropriate for the purposes of Section 112, the commenters felt they should be published and adopted as a Section 112 standard by reference (IV-D-698, IV-D-710, IV-D-810).

Response: The Agency believes that where standards established under other authorities are effective in reducing emissions, redundant standards need not be established by EPA. The EPA establishes separate standards when the evidence indicates either that the existing control measures are unlikely to remain in operation or that they will not be properly operated and maintained. The existing controls that EPA determined to represent best control at several primary copper smelters are likely to remain in place and be properly operated and maintained under the regulatory authorities that required those controls.

The existing process controls at primary copper smelters were installed primarily in response to SIP's or the judicial consent decrees worked out with smelters that had been found to be in violation of some of the requirements of SIP's. Although intended to reduce emissions of particulate matter and SO_2, these controls should also achieve effective control of arsenic emissions at some smelters. The efficiency of arsenic collection depends on the physical conditions (primarily temperature) affecting gases entering collection equipment and the concentration of inorganic arsenic in the gas stream. While the lowest practicable temperatures will permit the best arsenic collection, the minimum safe operating temperature is determined by the potential for corrosion problems caused by acid formation. Each smelter with existing particulate collection equipment was evaluated with respect to the potential to increase the collection of inorganic arsenic by lowering gas stream temperatures. The EPA concluded at proposal that at most smelters no appreciable additional arsenic collection through this measure was likely, and so the existing controls were considered to represent the best emission control. Following proposal, EPA reexamined the emission reduction achievable by gas cooling to determine any need for controls beyond those required by existing standards. Specifically, EPA reassessed the potential emission eduction achievable for those smelters where gas cooling was evaluated as a control option and for Phelps Dodge-Ajo. Process emission controls at Phelps Dodge-Ajo were examined because at proposal the company was negotiating changes to its consent decree to eliminate the need for oxy-sprinkle smelting and acid plant controls. Phelps Dodge has made the decision since proposal to continue its use of reverberatory furnace smelting at the Ajo smelter. As a result of this decision, EPA has reevaluated its analysis of the need for process controls at this smelter, based on the expected emission reduction and the costs of controls. These reassessments showed additional process controls would only achieve very small reductions in risk and would impose significant costs. Therefore, process controls should not be included in this standard. This issue is discussed further in Sections I-6.1.4, I-6.2, and I-8.1.3.2 of this document.

It is EPA's policy not to set redundant regulations where EPA believes that regulatory duplication would not lead to enhanced collection of a pollutant beyond the level of existing controls, or where it would not serve to further ensure that these existing controls would remain in place or be properly operated and maintained. NESHAP regulations are reviewed periodically as new information is obtained that may affect the stringency or applicability of the standards. At the time of review, the standard will be revised if necessary to provide the appropriate regulatory coverage. These reviews provide a means of ensuring that the current controls at a source (regardless of their regulatory origin) are continuing to perform at the level that satisfies the requirements of Section 112.

I-3.4 STARTUPS, SHUTDOWNS, AND MALFUNCTIONS

Comment: A few commenters felt that the proposed standard attempted to circumvent Section 112 of the Act; the regulation should not exempt emissions during startup, shutdown, and malfunctions from the control requirements. They further believed that the regulation should encourage compliance, and not provide a means and incentive for circumvention (IV-D-609, IV-F-4, IV-F-5).

Response: The regulation has been revised as it applies to emissions during startups, shutdowns, and malfunctions. The regulation includes maintenance requirements, and requirements for a plan for curtailment during malfunctions and timely repair of malfunctioning process and pollution control equipment. The regulation also now explicitly requires that emissions of inorganic arsenic be minimized at all times.

I-4.0 ARSENIC EMISSION ESTIMATES

Three copper companies, ASARCO, Kennecott, and Phelps Dodge, submitted comments pertaining to EPA's estimates at proposal of the baseline arsenic emission rates (i.e., emission rates in the absence of NESHAP controls) at several of their smelters. The commenters felt in each case that EPA had overestimated these emissions, and hence overestimated the risk posed to the public health in the vicinity of these smelters.

In response to these comments, the Agency revised many of its emission estimates and ran the Human Exposure Model (HEM) using the new data inputs to produce revised estimates of the potential public exposure and health risks from these smelters. These copper companies again commented when the revised emission estimates were placed into the docket for public comment (see Section I-1.0). (These later comments from ASARCO, Kennecott, Phelps Dodge and the State of New Mexico have been assigned item Nos. IV-D-811, IV-D-812, IV-D-813, and IV-D-814, respectively, in docket No. A-80-40). Most of these comments reiterated the concerns expressed at proposal, especially in cases where the Agency had disagreed with some of the assertions made by these companies. The responses in this section address principally the original comments made just after proposal, with reference made as necessary to the later group of comments. The smelter arsenic mass balances in Appendix F of the proposal BID have also been updated, and these are presented in Appendix B of this document. Appendix C contains an updated version of the proposal BID's Table E-2, showing the plant data inputs to HEM. This appendix also discusses other details of the modeling efforts undertaken since proposal.

I-4.1 ASARCO, INCORPORATED, SMELTERS

I-4.1.1 Hayden Smelter

Comment: ASARCO commented that the baseline converter fugitive arsenic emissions at its Hayden smelter would, in the modernized smelter, be much lower than EPA's estimate of 3.4 kg/h (7.5 lb/h). At the time of proposal, ASARCO was starting up a new INCO flash smelting furnace at the Hayden plant. ASARCO claimed in its comments that the new arsenic distribution at the modernized smelter would lead to a much lower fugitive emission rate of arsenic from converter operations than EPA had estimated at proposal.

Since INCO tests and estimates show that a higher percentage of the arsenic entering this furnace in the charge will be volatilized (78 percent versus EPA's estimate of 49 percent), and thus will not enter the converters in the matte, a smaller quantity, 32 kg/h (70 lb/h), will be given off in the converter offgases than EPA's estimate of 45 kg/h (99 lb/h).

The emission factor of 15 percent of the arsenic contained in the primary offgas stream, which EPA used to estimate potential (uncontrolled) converter fugitive emissions, was claimed to be too high under the new INCO furnace configuration. The sampling conducted for EPA in

January 1983, on the prototype air curtain secondary hood installed on the No. 4 converter at ASARCO-Tacoma showed that a 2 percent emission factor may be more appropriate for a converter equipped with a high-draft primary hood. Since the primary hoods at the Hayden smelter also will be operated under a high draft (potentially even higher than at Tacoma), the same fugitive emission factor of 2 percent should be applied at Hayden in order to calculate potential converter fugitive emissions. ASARCO felt that even the 2 percent factor would be conservative because of the Hayden hoods' higher draft and the likelihood of fewer converter cycles at Hayden than at Tacoma, decreasing the chance for the escape of fugitive emissions. In its recent comments on EPA's response memorandum, the company claimed that the Agency's rationale presented in the memo for maintaining the 3.75 percent primary hood emission factor had relied on the presence of secondary hoods as a determining influence in its estimation of this factor. ASARCO felt that the existence or type of secondary hoods is not relevant for estimating potential fugitive emissions from converters. The company applied its estimated emission factor of 2 percent to the 32 kg/h (70 lb/h) figure cited above, producing a potential fugitive arsenic emission rate estimate of 0.6 kg/h (1.4 lb/h) for the converter operations at its Hayden smelter.

Finally, ASARCO claimed that the capture efficiency of the existing secondary hoods at the modernized smelter is actually 75 to 80 percent, rather than the 50 percent estimated by EPA. The company, in its comment on EPA's August 1984 memo, provided records of the sulfur balance at the smelter both before and after modernization. These records indicated that the sulfur lost (presumably in the form of fugitive emissions) in 1981-82 when the roasters and reverberatory furnace were still in operation averaged about 4.5 percent of the total input sulfur. By contrast, records for 1984 with the oxygen flash furnace in operation show that only about 0.02 percent of sulfur intake is now lost, indicating a marked improvement in fugitive emission control since EPA's observations of the smelter operation in 1981. ASARCO applied its estimate of 75 percent capture to the potential fugitive emission rate of 0.6 kg/h (1.4 lb/h) to calculate a converter baseline fugitive emission estimate of 0.16 kg/h (0.35 lb/h). The company felt that this converter fugitive emission level should cause the smelter to be considered to already have best emission controls installed (IV-D-620, IV-D-811, IV-F-1, IV-F-2).

Response: The EPA's reanalysis of the ASARCO-Hayden smelter's inorganic arsenic distribution and new estimates of converter fugitive emissions have resulted in several changes to the estimates made by the Agency at proposal.

The Agency's estimate at proposal of 49 percent arsenic volatilization from the INCO flash furnace was based on an estimate submitted to EPA for the INCO furnace planned for the Kennecott-Hurley smelter (II-D-43); the same value of 49 percent was applied to the INCO furnace at ASARCO-Hayden in order to generate a complete arsenic distribution for the smelter. This was done because no estimate had been received from ASARCO. However, since ASARCO now claims that a value of 78 percent volatilization is more appropriate, and this value falls within the range of data reported in the literature and presented in Table 2-7 of low-arsenic BID, Volume I, the 78 percent value was used in developing a revised arsenic balance for the Hayden smelter. (The higher volatilization rate was accepted because the arsenic content of feedstocks used at ASARCO-Hayden is more than 1,000 times greater than that of Kennecott-Hurley and because tests indicate that a higher percentage of arsenic is generally volatilized in a smelting furnace from higher arsenic feed materials.) Values of 8 and 14 percent were used for estimating the quantities of arsenic from the furnace charge reporting in the slag and the matte, respectively. The rate of arsenic volatilization in the converters was assumed as before to be 50 percent, resulting in an estimated rate of 32 kg/h (70.2 lb/h) of arsenic given off in the converter offgases.

The EPA's emission factor of 15 percent of the arsenic contained in the converter primary offgases, used at proposal for estimating potential converter fugitive emissions, was based on test data collected at the ASARCO-El Paso smelter (page 2-53 of low-arsenic BID, Volume I). This emission factor is appropriate for converting operations that utilize converter primary hoods drawing a relatively low draft. This is the case at most domestic copper smelters, where low-draft operation minimizes dilution of SO_2 concentration in the flue gases being ducted to acid plants, and hence optimizes acid plant operation. ASARCO has claimed that under the new INCO furnace configuration, the furnace offgas containing 80 percent SO_2 will be blended with converter offgases before being sent to an ESP and two acid plants. These acid plants are designed to operate at SO_2 concentrations of 6.5 and 12 percent. Therefore, a large quantity of dilution air will be required, and a portion of this dilution air will be supplied by means of an increased draft on the converter primary hoods. As a result, fugitive emissions should be lower.

The EPA agrees with ASARCO that converter primary hoods should capture process emissions more efficiently under high-draft operation than under lower draft conditions. Furthermore, the emission factor of 15 percent selected by the Agency at proposal did not take high-draft operation at ASARCO-Hayden into account. Therefore, EPA revised the emission estimate to reflect the expected capture efficiency of high-draft primary hoods. Observation and measurement of emissions from primary hoods at ASARCO-Tacoma show that secondary converter emissions vary with the hood-converter configuration and the draft. Fugitive emission factors for converters at ASARCO-Tacoma are 3.75 percent for primary hoods in converters Nos. 1 and 2 and 2 percent for converter No. 4 at Tacoma (IV-B-10, IV-B-30). The 2 percent emission factor measured for the Tacoma smelter's No. 4 converter represents the best operation EPA has observed with regard to primary hood emission capture. The EPA has not been made aware of any data collected from the ASARCO-Hayden operations to establish the actual emission factor, and ASARCO has not supplied any such information with its comments. Therefore, the Agency believes that, when no actual measurements are available, it is prudent to select an emission factor representative of high-draft operation, as determined for converter Nos. 1 and 2 at Tacoma, but not as low as the factor measured for the best system. For this reason, a selected emission factor of 3.75 percent has been used to estimate potential fugitive arsenic emissions from the converters at

ASARCO-Hayden. (Note: The company pointed out some errors of statement in EPA's memorandum response. This response had referred to the measured 2 percent emission factor at ASARCO-Tacoma as relating to secondary hood capture and had termed it an "air curtain factor." These were errors of statement drafted into the technical memo, and EPA believes that when the terminology is corrected to refer to primary hood emission factors, the logic of its rationale is sound. The EPA did not intend in its memo response to imply the existence of any connection between the presence or type of secondary hoods and the primary hood capture efficiency.)

To support its estimate of 75 to 80 percent capture efficiency for the secondary hoods, ASARCO provided a summary of sulfur recovery data for 10 months in 1981 and 1982 before the smelter was modernized, and for 8 months in 1984 after modernization was completed. Inspection of these data shows that three of the pre-modernization months actually showed gains in sulfur recovered versus sulfur input in the copper concentrate (2.0, 3.0, and 7.7 percent). Also, while the amount of sulfur lost for the entire period totalled 4.5 percent, the loss for individual months ranged from 2.4 to 12.5 percent. Data for four of the post-modernization months indicated that recovered sulfur was greater than input sulfur by 1.2, 3.7, 3.8, and 9.4 percent, while the losses calculated for the remaining months ranged from 0.5 to 7.9 percent. These figures show that this method of sulfur accounting is insufficiently precise to permit any definite conclusions about fugitive emission control. Analysis of the data shows that there is no discernible difference between the mean sulfur recovery values at the 95 percent confidence level (IV-B-36). Therefore, the submitted data do not demonstrate that hood capture efficiency was improved during the smelter modernization. Furthermore, EPA believes that to develop revised estimates of hood capture efficiency would require inspection of the facility and additional information. Because further reductions in emission estimates are not likely to affect decisions regarding the standard, EPA concluded this effort would not be a productive use of resources and the capture efficiency should not be revised from 50 to 75 or 80 percent.

The revised volatilization rate of arsenic from the furnace and the fugitive emission factor for the converters at Hayden discussed above have been used in calculating estimated inorganic arsenic emissions from the ASARCO-Hayden smelter. The revised arsenic distribution (Figure B-2) is presented in Appendix B, and the corresponding arsenic emission input data for the exposure model are contained in Appendix C. The EPA's estimate of baseline converter fugitive emissions is now 0.6 kg/h (1.3 lb/h), which is 17 percent of the proposal estimate, and about four times the estimate submitted by ASARCO in its comments.

Using the above estimates of the capture efficiency of the existing control system, EPA has determined that further control of converter fugitive emissions can be achieved only at a cost that is greatly disproportionate to the risk reduction achieved. Therefore, the standard does not require control of converter fugitive emissions at this smelter, as it is currently being operated. Further reductions of the arsenic emission rate also would not affect the applicability of the standard.

I-4.1.2 El Paso Smelter

Comment: ASARCO claimed that EPA had overestimated at proposal the baseline converter fugitive emissions at its El Paso smelter. The smelter's converter building evacuation system was credited by EPA with 75 percent capture efficiency, which is significantly lower than the potential capture of this type of system. Emergency roof ventilators and a large access door left open to help alleviate heat and dust accumulation had contributed to this low estimated efficiency. However, ASARCO related in its comments that changes to the system had been made recently, including the sealing of the roof ventilators and the closing of the access door. The capture efficiency was now judged by ASARCO to be about 90 percent (IV-D-620, IV-F-1, IV-F-2). The State of New Mexico, commenting on EPA's revised arsenic emission estimates, felt that the recent improvements made to the building evacuation system at ASARCO-El Paso should be detailed and made mandatory in the NESHAP. This would ensure that the system continued to be operated properly and that the 90 percent capture efficiency was maintained (IV-D-814).

ASARCO also referred to another improvement at the smelter, the installation of a new computerized gas management system in the primary converter hood flue. The company thought that, because of this system, EPA should lower its proposal estimate of potential (uncontrolled) converter fugitive emissions by decreasing its selected emission factor of 15 percent. ASARCO did not, however, provide an alternate estimate (IV-D-620, IV-F-1, IV-F-2). In its comments on EPA's response memorandum, ASARCO took issue with EPA's decision to consider two values for the primary hood emission factor as likely upper and lower limits of the actual value. The company felt that the lower value of 3.75 percent should be used in EPA's analysis of converter fugitive emissions at the El Paso smelter (IV-D-811). The State of New Mexico felt that, since improved primary hood performance had not been demonstrated at ASARCO-El Paso following the installation of the computerized gas management system, EPA should not allow credit for improved capture and should continue to use the emission factor of 15 percent until the improvement can be verified (IV-D-814).

Response: The converter building evacuation system at the ASARCO-El Paso smelter was estimated by EPA at proposal to be approximately 75 percent efficient due to the extra building openings that were allowing fugitive emissions to escape capture.

The EPA requested clarifying information about the current situation at the El Paso smelter in a request sent to ASARCO after proposal (IV-C-418). In its response (IV-D-789), ASARCO related that in the past year it had made several changes within the converter building to reduce employee exposure and minimize fugitive emissions. These changes had included repairing loose siding on the building wall, closing a crane access door, and expanding the smelter's computerized environmental monitoring system to manage process gas flows. Although ASARCO stated that heat levels in the building are still excessively high, it is likely that the building evacuation system is now operating at a level much nearer to its potential capture efficiency than before.

The EPA also sent contractor representatives to conduct a site visit to observe performance of the building evacuation system. During the site visit, the operation of the computerized gas management system was discussed and visible emissions observations were made within and without the building. The visible emissions observations and evaluation of the repaired building evacuation system showed that a capture efficiency of about 90 percent is being achieved. Thus, for the purposes of reanalysis of arsenic emissions from this smelter, EPA now is assuming a capture efficiency of 90 percent for this system. (Section I-6.5 contains a further discussion of the building evacuation system.)

ASARCO described its computerized gas management system for the copper converters as having three separate functions: tuyere air control, converter hood pressure control, and handling of offgas (damper control). These functions work together to control and smooth out pressure and flow surges inside the converters, in the converter hoods, and in the exhaust gas handling system between the hoods and the ESP. The system senses converter position and gas pressures in various parts of the gas handling system and adjusts tuyere blowing rates and damper positions to optimize capture of converter offgases by the converter hoods. ASARCO believes that the reduced frequency of positive pressures and the stabilized gas flowrate demonstrate that the computerized gas management system has reduced fugitive and process emissions. The EPA has considered the operation of the El Paso smelter's gas management system in its reassessment of potential converter fugitive emissions. Although the capture efficiency of the converter hoods has not been measured since the system was upgraded, EPA believes that it is likely to be higher than the efficiency of a similar low-draft primary hood system without computerized control, and may in fact be similar to a high-draft system such as the system at ASARCO's Hayden smelter. However, ASARCO did not provide any test measurements verifying its claim of a lower potential fugitive emission factor. Therefore, the Agency feels that at this time it cannot select an appropriate factor, and is retaining the upper and lower limit values of 15 and 3.75 percent presented in the response memorandum. The latter value was selected to correspond to the emission factor applied to the ASARCO-Hayden smelter, where the primary hoods are operated under a high draft.

As a result of these considerations, EPA has reviewed its proposal estimate of 3.2 kg/h (7.0 lb/h) or 27.5 Mg/yr (130.3 tons/yr) for baseline converter secondary arsenic emissions at ASARCO-El Paso. This estimate is now expressed as a range, to account for the two values for primary hood capture efficiency under consideration by the Agency. The highest level of secondary emissions (1.5 kg/h [(3.4 lb/h] or 13.3 Mg/yr [14.7 tons/yr]) occurs under the assumed primary hood fugitive emission factor of 15 percent (85 percent capture efficiency). If the lower emission factor of 3.75 percent (96.25 percent capture efficiency) is assumed to apply, the calculated converter secondary emissions are reduced to 0.4 kg/h (0.9 lb/h) or 3.4 Mg/yr (3.7 tons/yr).

The EPA used these emission rate estimates to assess the range of possible impacts and cost effectiveness of the standard, because more definitive values based on testing or Agency observations are not presently available. These analyses demonstrated that the precise level of emission reduction achieved due to operation of this automatic gas management system would not affect the Agency's decision to require control of converter fugitive emissions at ASARCO-El Paso.

In response to New Mexico's comment about the configuration of the building evacuation system, EPA reviewed its analysis of the operations within and the emissions from the converter building at the ASARCO-El Paso smelter to ensure that the Agency's analyses and decisions were based on the best information available. This reassessment included: (1) an on-site inspection of the converter building ventilation system, and (2) discussions with ASARCO regarding anticipated future operation of the system after installation of the converter secondary hoods and the impact of the computerized gas management system on fugitive emissions. The on-site inspection, made in January 1985, showed that the converter building evacuation system is achieving about 90 percent capture efficiency; EPA believes that if the existing total flow rate from the converter building is maintained after installation of the converter secondary hoods, the capture efficiency of the building evacuation system should not be diminished. The EPA also recognizes that the converter secondary hoods could, by altering the dispersion of emissions and gas flow within the building, affect the performance of the building evacuation system. Since the design of the ventilation system incorporating the converter secondary hoods has not yet been established, EPA cannot determine what the effects on building flows will be and whether it is necessary to require maintenance of 90 percent capture efficiency in the converter building. The Agency also cannot determine whether it is necessary or reasonable to maintain 90 percent capture efficiency in light of uncertainties about the emission factor for the anode furnace and the converter fugitive emission factor, and their effect on estimates of fugitive emissions from the building. To determine the necessary level of control, it would be necessary to monitor emissions, air flows, and system changes after installation of the converter secondary hoods.

From discussions with ASARCO and review of applicable State (Texas) requirements, EPA concluded that ASARCO will continue to maintain the converter building in its present condition if this can be done without increasing worker exposures and creating unacceptably high temperatures in the work area (IV-E-79, IV-E-80, IV-E-82). While it appears likely that ASARCO will maintain a relatively closed building, neither EPA nor ASARCO can determine with certainty whether this will be technically feasible. Therefore, the standard does not include provisions requiring maintenance of 90 percent capture efficiency in the converter building or maintenance of the measures that have been taken by ASARCO to seal the building. The standard does, however, require ASARCO or the owner or operator of any other facility that might be required to install converter secondary hoods to report any significant changes in the operation of the emission control system capturing and controlling emissions from converter operations. Examples of changes that must be reported are reductions in air flow through the capture system of more than 20 percent and an increase in the area of the converter building that is open to the atmosphere. Since changes could affect the capture efficiency achieved by the secondary hoods and the building evacuation system, EPA will evaluate all such changes.

I-4.2 KENNECOTT SMELTERS

I-4.2.1 Utah Smelter

Comment: Kennecott supplied a revised arsenic material balance for its Utah smelter which it claimed reflected small changes in process operations and more accurate assays than had been performed previously. (Kennecott's smelter near Garfield, Utah, was referred to as Kennecott-Garfield by EPA at the time of proposal.) For example, the total smelter arsenic input increased to 122 kg/h (269 lb/h) from EPA's proposal estimate of 115 kg/h (253 lb/h), as a result of more accurate assays on precipitates and residues. Arsenic input to the converters decreased from 19.2 to 14.8 kg/h (42.4 to 32.5 lb/h) because Kennecott now uses barren flux (flux with essentially no arsenic content) in the converters.

According to Kennecott, the Noranda flash smelting reactors at the Utah smelter produce a higher grade matte (higher copper content) than typically produced by reverberatory furnaces (70 percent versus under 45 percent). Since arsenic is soluble in copper, a higher percentage of the arsenic in the matte is retained in the blister copper produced from the matte, and therefore the amount of arsenic volatilized in the converter is lower. Kennecott claimed that EPA's estimate at proposal of 32 percent volatilized in the converter offgases (low-arsenic proposal BID, page F-12) is too high; the figure is actually closer to 10 percent. Kennecott also submitted a revised arsenic mass balance for the Utah smelter that shows 1.2 kg/h (2.6 lb/h) of arsenic eliminated in the converter offgases, in contrast to EPA's estimate at proposal of 6.2 kg/h (13.7 lb/h). The company further stated that in-house testing showed the capture efficiency of the existing converter fugitive ventilation system to be greater than 90 percent, indicating that EPA's proposal estimate of 50 percent was too low (IV-D-634). In later comments on the revised emission estimates in EPA's response memorandum (IV-B-32), Kennecott submitted additional arguments and information to demonstrate that these converter secondary hoods are achieving a 90 percent capture efficiency (IV-D-812).

Kennecott estimated baseline arsenic fugitive emissions from the roof vents in the smelter building using SO_2 emissions measurements and assuming that the ratio of arsenic to SO_2 at the roof vents would be the same as that measured in the stack gas. Escaped fugitive arsenic emissions were estimated to be 0.06 kg/h (0.13 lb/h), in contrast to EPA's estimate at proposal of 0.9 kg/h (2.0 lb/h) (IV-D-634).

Response: The arsenic mass balance information used by EPA at proposal for developing the arsenic mass balance for the Kennecott-Utah smelter was obtained directly from Kennecott in May 1978, and March 1983 (Section F.5 of BID, Volume I). The basic changes to this balance suggested by Kennecott since proposal have been accepted by EPA and incorporated into a revised arsenic balance (see Appendix B).

After reviewing Kennecott's comments on the proposed standard, EPA requested that the company supply additional information (IV-C-416) to clarify and support their claims, and to resolve apparent inconsistencies with the information previously supplied to the Agency. Kennecott's response (IV-D-788) included a technical memorandum addressing the issue of arsenic volatilization during copper converting at the Utah smelter. Several aspects of the converting operation that contribute to the low arsenic content of the converter offgases were cited. Among these is the routine use of oxygen enrichment of the blast air combined with maximum additions of reverts and copper scrap early in the blowing phase. This results in lower average converter operating temperatures (approximately 1,150°C [2,100°F]), which was claimed to result in lower arsenic volatilization rates. In addition, processing higher grade mattes and mattes with a lower arsenic content (such as those at the Utah smelter) was said to result in a decreasing rate of arsenic volatilization in converters. Since EPA found these arguments to be reasonable, EPA's revised arsenic balance incorporates these comments and shows an arsenic volatilization rate of 1.2 kg/h (2.6 lb/h), which represents only 8 percent of the total arsenic charged to the converters.

Kennecott's estimate of 0.06 kg/h (0.13 lb/h) of arsenic fugitive emissions escaping through the converter building roof vents is not based on actual arsenic measurements at those vents. Rather, it is based on measurements of the vent gas SO_2, main stack SO_2, and main stack arsenic content, and the assumption that the roof vent gas arsenic-to-SO_2 ratio would approximate that for the main stack gas. Given values for the measured data, an estimate of the roof vent arsenic emission rate can then be calculated. In response to EPA's request after proposal for clarifying information, Kennecott stated that the stack value for SO_2 used in its calculations (8196 kg/h [18,052 lb/h]) was the annual average measured value for 1981, stack arsenic was a value from measurements made in 1982 (1.8 kg/h [4 lb/h]), and roof vent SO_2 was measured in an October 1981, test program (269 kg/h [593 lb/h)]. The EPA believes there is no direct evidence to support Kennecott's assumption that the arsenic-to-SO_2 ratios in the stack and the roof vent gas are approximately equal and, in the absence of measurements of vent gas arsenic content, the Agency cannot accept Kennecott's estimate of 0.06 kg/h (0.13 lb/h) resulting from this assumption. Also, this method assumes that all emissions escaping capture by the primary hood system are either captured by the secondary hoods or escape out the roof vents. As stated in the response memorandum, EPA believes that a more valid comparison of arsenic-to-SO_2 ratios would be between two similar untreated gas streams, such as the roof vent gas stream and the converter primary hood system offgas stream. Kennecott's alternate method of estimating fugitive emissions and secondary hood capture efficiency, submitted with its comments on EPA's revised estimates, does employ such a comparison, but this alternate method also does not provide an accurate assessment of hood capture efficiency.

While Kennecott's alternate approach to estimating fugitive emissions escaping from the converter building compares two gas streams that are more similar than those compared in the company's first approach, the latter approach assumes again that all of the arsenic not measured in the roof vents has been captured by the secondary hoods. This analysis, however, fails to account for all of the likely routes of escape in the building for converter arsenic fugitive emissions. Specifically, there is an open roof monitor over the hot metal side of the building through which emissions can escape, as well as crane doors, windows, and other smaller openings. These additional emission routes introduce sufficient uncertainty into this estimating approach to cause the Agency to conclude that the approach is not sufficiently reliable for estimating hood capture efficiency. It should be noted that if the emission estimate had been revised as suggested by Kennecott, there would have been only a negligible impact on the estimated risk calculated for the smelter. Also, a lowering of the arsenic emission estimates for Kennecott-Utah would not impact the regulatory decisions for this smelter.

The EPA's estimate at proposal of the capture efficiency of the existing converter fugitive ventilation system was 50 percent. Kennecott's estimate of 90 percent capture efficiency submitted to EPA after proposal was based on measurements made in October 1981 of the SO_2 discharged to the atmosphere from the smelter building roof vents, and a sulfur balance for the converters. The hourly amount of SO_2 produced in the converters was calculated using the amount of matte processed by the converters (26,400 Mg [29,100 tons]) and its average sulfur content (21.2 percent) for the month of October 1981. Assuming that all of the sulfur in the matte was oxidized to SO_2, and knowing that each mole of sulfur produces one mole of SO_2, the production rate of SO_2 was calculated to be 15,060 kg/h (33,166 lb/h). This calculated SO_2 production and the measured SO_2 emissions from the converter aisle roof vent fans (210 kg/h [462 lb/h]) were used to calculate an estimate for the capture efficiency of the converter fugitive ventilation system. The EPA believes that this indirect form of calculation is not sufficient for deriving an estimate of the capture efficiency of the converter fugitive ventilation system, and questions whether measurements of SO_2 can reliably be substituted for inorganic arsenic measurements because of the potentially different behavior of these two substances. Also, as mentioned in the previous paragraph, there are other emission routes for SO_2 in this building than the roof vents at which the measurements were taken. Therefore, EPA does not feel that all of the secondary SO_2 unaccounted for at the roof vents is captured by the converter secondary hoods, and believes that the apparent capture efficiency indicated by this method is considerably higher than the true efficiency. In addition to these considerations, observations made on a visit by EPA and contractor personnel to the Kennecott-Utah smelter in November 1983, suggested that a substantially lower capture efficiency was achieved (IV-B-26). As a result, EPA retained its 50 percent estimate of capture efficiency in the reanalysis of fugitive emissions from the Kennecott-Utah smelter.

The EPA's revised value for baseline converter fugitive emissions is 0.18 kg/h (0.39 lb/h), or 19 percent of its previous estimate at proposal.

I-4.2.2 Hayden Smelter

Comment: Kennecott submitted a figure depicting the overall arsenic material balance for its Hayden smelter that is similar to the overall arsenic balance EPA utilized at proposal (Figure F-6 in low-arsenic proposal BID), except for the estimate of main stack emissions. Whereas EPA's figure showed 3.2 kg/h (7.0 lb/h) of arsenic exiting through the main stack, Kennecott indicated that this emission value should have been only 0.24 kg/h (0.53 lb/h). Kennecott repeated its objection in comments the company submitted on EPA's response memorandum (IV-B-32), but no specific objections to any of EPA's other values or assumptions were stated. While basically agreeing with EPA's estimate of total fugitive emissions (0.9 kg/h [2.0 lb/h]) for lack of any more detailed information, Kennecott asserted that improvements made to the smelter since it shut down in May 1982, would bring about a substantial reduction in fugitive emissions. In its later set of comments, Kennecott supplied a list of specific improvements to fugitive emission controls, and estimated that the improvements would reduce fugitive emissions from the Hayden smelter by approximately 50 percent (IV-D-634, IV-D-812).

Response: The arsenic mass balance figure for the Hayden smelter was developed by EPA using data received from Kennecott concerning the arsenic feed rate to the smelter, as well as several assumptions about the further distribution of arsenic out of roasters, furnace, and converters. These assumptions included respective volatilization rates from these three process steps of 15, 36, and 70 percent. Further, as indicated in Table 4-4 of low-arsenic proposal BID, the hot ESP (260°C) controlling process emissions from the reverberatory furnace (and discharging through the main stack) was assumed to control arsenic at 40 percent efficiency. This is consistent with Agency observations of arsenic collection by control devices in smelter hot process streams. Since Kennecott supplied only an overall balance figure, and not a detailed figure similar to EPA's BID I Figure F-6(a), the Agency cannot determine which of its assumptions are being objected to by Kennecott. Kennecott's suggested main stack arsenic emission rate of 0.24 kg/h (0.53 lb/h) appears to rely on an assumption of approximately 95 percent control efficiency for the hot ESP controlling furnace arsenic emissions, although this was not stated by Kennecott. Since available emission test data for hot ESP's (Phelps Dodge-Ajo) show collection efficiencies of about 30 percent, the Agency believes that 95 percent control efficiency apparently assumed by Kennecott for arsenic is much too high. Since Kennecott provided no documentation for its assumption of this extremely low main stack arsenic emission rate, EPA is continuing to base its calculation of risks due to the Kennecott-Hayden smelter on its calculated rate of 3.2 kg/h (7.0 lb/h).

Kennecott's submittal outlining specific smelter improvements does not conclusively demonstrate that fugitive emissions have been reduced by 50 percent from previous levels. The EPA has retained its estimate of 0.91 kg/h (2.0 lb/h) made at proposal, because it is based on reasonable assumptions about current controls at this smelter.

I-4.2.3 McGill Smelter

Comment: Kennecott claimed that in 1982 the McGill smelter was custom smelting high-arsenic concentrates from the Butte, Montana, mine after the Anaconda smelter shut down. The arsenic concentration of this feed was atypically high for Kennecott-McGill, and this smelter is not now smelting, nor does it have any plans to smelt in the future, high-arsenic concentrates (such as those from the Butte mine). Kennecott estimated that stack arsenic emissions at the McGill smelter are about 5.5 kg/h (12.1 lb/h) and fugitive emissions are about 1.5 kg/h (3.4 lb/h). At proposal, EPA estimated stack emissions to be 45.8 kg/h (100.9 lb/h) and fugitive emissions to be 5.3 kg/h (11.7 lb/h) (low-arsenic proposal BID, p. 4-14 and F-19).

Kennecott also felt that EPA had understated at proposal the degree of arsenic capture at the smelter as defined under the baseline control case. The company referred to anticipated improvements at the smelter that would reduce fugitive emissions, but did not specify the details of the improvements (IV-D-634). In its comments on EPA's memorandum containing revised estimates of smelter arsenic emissions, Kennecott repeated that the controls planned under State regulations should be considered in defining the baseline emission configuration for the McGill smelter (IV-D-812).

Response: The EPA requested further details about the McGill smelter operation from Kennecott subsequent to proposal in a request for information made under Section 114 of the Act (IV-C-416). In its response (IV-D-788), Kennecott supplied a figure for the hourly capacity feed rate of concentrates to the smelter (680 Mg/day or 28.4 Mg/per hour [750 TPD or 31.25 tons per hour]), but was unable to provide any specific information on sources, amounts, or arsenic content of concentrates that will be processed at McGill over the next 5 years. Kennecott did indicate, however, that the smelter would be operated primarily as a toll smelter. In order to estimate baseline arsenic emissions and the impact of NESHAP controls, EPA made the assumption that the Kennecott-McGill smelter would be processing ore concentrates similar in arsenic content to those processed by other toll smelters in the Southwest such as the Inspiration Consolidated Copper Company smelter at Miami, Arizona, which processes a smelter charge containing 0.033 percent arsenic (Table 2-3 of BID, Volume I). This assumption is consistent with Kennecott's stated position in its response after proposal that the materials processed at McGill in the future will be similar to concentrates processed at other toll smelters. The resultant arsenic feed rate to the smelter used to develop the revised arsenic mass balance for Kennecott-McGill presented in Appendix B (Figure B-8), and the new emission estimates, is 9.4 kg/h (20.6 lb/h). The revised estimates for arsenic emissions from the main stack and for converter fugitive emissions are 11.9 kg/h (26.2 lb/h) and 1.2 kg/h (2.6 lb/h), respectively.

In its request for further information after proposal, EPA asked for details on the anticipated improvements at the McGill smelter. The company replied that it has undertaken an option agreement with White Pine County, Nevada, which would require controls (planned for operation by March 1986) to reduce SO_2 emissions by 60 percent. This control equipment would include a single contact acid plant plus the associated hood and flue capture systems to achieve the necessary SO_2 control. Kennecott stated in its comments on EPA's revised estimates that these controls will be required to meet the Nevada SIP for SO_2 regardless of whether the option is exercised. Since these SO_2 controls are on a definite schedule to be incorporated at the McGill smelter, the company believed that emission reduction credit should be assumed in EPA's revised estimates. The Agency has considered Kennecott's descriptions of the planned controls on SO_2 emissions at the McGill smelter, and believes that at this time insufficient information is available on the nature and expected arsenic control efficiency of these controls to quantify the impact on arsenic fugitive emissions. In addition, these potential controls are considered too far from realization to qualify for inclusion in the baseline, since the deadline for their installation is well beyond 90 days after the promulgation of this NESHAP. This approach is consistent among all of the smelters, and constitutes a conservative, reasonable decision in accord with EPA's goal of minimizing public health risk. Therefore, the Agency is continuing to consider the baseline control situation at this smelter to be represented by the present control configuration (hot ESP on reverberatory furnaces, multicyclones on converter process gases, and local capture of matte and slag tapping emissions) without the new controls. Further, since EPA has determined that only a very small risk reduction would result from the installation of best emission controls at Kennecott-McGill, and that therefore such controls should not be imposed, the consideration of additional planned controls in the baseline would have no impact on the regulatory decision for this smelter.

I-4.3 PHELPS DODGE SMELTERS

I-4.3.1 Morenci Smelter

Comment: Phelps Dodge commented that the arsenic feed rate to its Morenci smelter, which the company had supplied to EPA in April 1983, and was used by the Agency at proposal to estimate smelter arsenic emissions, was an assumed distribution used in computer modeling of the smelter that overestimated the actual feed rate. Similarly, the figure for arsenic feed rate to the converters was a theoretical distribution that later was found to be much higher than actual smelter data indicated. After proposal, the company examined samples of smelter material from each year back to 1978 and found that the actual annual average matte (converter feed) arsenic values ranged from 0.14 to 0.28 kg/h (0.30 to 0.60 lb/h), and at no time exceeded 1.7 kg/h (3.7 lb/h) (IV-C-417, IV-D-640, IV-D-785, IV-F-1, IV-F-6).

Response: The EPA requested clarifying information from Phelps Dodge after proposal (IV-C-417) concerning the company's claim about the lower arsenic feed rate to the smelter and into the converters. The company provided monthly average values for the arsenic content of the smelter feed in 1983 (IV-D-785); the annual average value was 3.4 kg/h (7.5 lb/h). EPA's previous estimate of 4.4 kg/h (9.6 lb/h) has been replaced by this lower value in the updated arsenic mass balance for the Morenci smelter (Figure B-13 in Appendix B). The estimated rate of arsenic input to the smelting furnace now totals 12.6 kg/h (27.8 lb/h), which in addition to the 3.4 kg/h (7.5 lb/h) feed rate in the concentrate, includes 8.9 kg/h (19.7 lb/h) in the dust and 0.27 kg/h (0.6 lb/h) in the converter slag recycled to the furnace (slightly lower than previous estimates).

In response to EPA's request for clarifying information on the feed rates to the converters, Phelps Dodge responded that it had found in recent sampling (February 1984) during oxy-sprinkle operation (which

EPA had assumed to be the baseline configuration), that matte arsenic levels will not increase above levels reported previously for reverberatory operation, and may actually be lower. They pointed out, however, that the recent measurements provide only tentative values, and further testing is necessary to establish consistent values. The EPA has decided to calculate the arsenic feed rate to the converters for the updated arsenic distribution utilizing the arsenic percentages suggested in the arsenic mass balance figure submitted by Phelps Dodge after proposal (which reflects the recent sampling efforts). These percentages are 60 percent of the arsenic input to the furnace volatilized, 26 percent slagged, and 14 percent or 1.7 kg/h (3.8 lb/h), reporting in the matte charged to the converters.

The EPA has run the exposure model using the lower arsenic emission estimates reflected by the revised arsenic distribution. Modeling input parameters are presented in Appendix C.

I-4.3.2 Ajo Smelter

Comment: Phelps Dodge claimed that a "drastic overestimation" of arsenic emissions from its Ajo smelter had been made in the proposal, since EPA relied on data from a limited period unrepresentative of the present and future situation at this smelter. The arsenic levels in the concentrate feed when tests were performed in 1976 and 1978 (0.3 percent) were the highest levels recorded in 17 years, and the figure should be corrected to reflect the current level of 150 ppm. Examination of the remaining valuable ores at the Ajo mine reveals that the high arsenic levels experienced in the past will not recur.

Phelps Dodge also referred to two control measures at the Ajo smelter, which they felt EPA had overlooked when the proposal was developed, and which should further reduce the public exposure to inorganic arsenic near the smelter. These controls include the installation of fugitive gas capture systems for matte and slag tapping, and dust suppression practices in the copper concentrate handling area of the smelter (IV-D-640, IV-F-1, IV-F-6).

Response: To quantify the assertion of Phelps Dodge concerning EPA's overestimation of the current arsenic feed rate to the Ajo smelter, EPA requested further information from Phelps Dodge under Section 114 of the Act (IV-C-417). The company responded that a reasonable (assumed) average concentrate feed rate to this smelter is 20 Mg per hour (22 TPH) (IV-D-785). Combining this value with the average arsenic content of the feed of 150 ppm, the rate at which arsenic is fed (in the concentrate) into the smelter is now estimated at 3.0 kg/h (6.6 lb/h), compared to EPA's previous estimate of 46.8 kg/h (103 lb/h). (The total feed, including recycled materials, is now 3.9 kg/h [8.6 lb/h], compared to the previous estimate of 59.4 kg/h [130.9 lb/h].) The EPA accepted the company's revised arsenic feed rate estimate since the smelter owner is in the best position to determine this quantity on the basis of current measurements. The lower value of 3.9 kg/h (8.6 lb/h) has been incorporated into a revised arsenic mass balance for the Ajo smelter (Figure B-10) which is presented in Appendix B.

As indicated in Section 4.3.2.10 of low-arsenic BID, Volume I, the baseline smelter configuration assumed for Phelps Dodge-Ajo at proposal included an oxy-sprinkle modified reverberatory furnace. The arsenic distribution exiting this furnace was assumed to be 76 percent volatilized, 17 percent slagged, and 7 percent reporting in the matte (Figure F-10(a) of BID I). However, since proposal EPA has learned that the consent decree that would have dictated this furnace conversion has been amended such that no furnace conversion now will take place. Therefore, a distribution of arsenic appropriate to the unmodified reverberatory furnace has been assumed in the revised mass balance. These percentages are 55 percent of the arsenic volatilized, 25 percent slagged, and 20 percent reporting in the matte.

Fugitive emission controls on matte and slag tapping operations at the Ajo smelter were not overlooked in the development of the proposed arsenic standards. Table 4-5 of BID, Volume I, indicates capture efficiencies of 90 percent for both of these sources of fugitive emissions. However, these captured emissions from matte and slag tapping are not collected in control equipment, but are vented directly to the main stack (page 4-29 of BID I). For this reason, the emission reduction efficiency for these sources of fugitive emissions is zero. Therefore, Table III-2 in the proposal preamble (at 48 FR 33144) indicates no difference between potential and baseline secondary emissions from matte and slag tapping operations at Phelps Dodge-Ajo. The risk modeling did, however, account for the higher release height of the captured portion (90 percent) of these fugitive emissions. These controls were assumed to be in operation for the calculation of baseline arsenic fugitive emissions at Phelps Dodge-Ajo at the time of proposal and are retained in the revised emission calculations. Concerning dust suppression in the concentrate handling area, only fugitive emission sources within the process area of the smelter were considered in estimating total fugitive emissions from the smelter. Thus, no fugitive emission factor was developed for concentrate handling.

I-4.3.3 Hidalgo Smelter

Comment: Phelps Dodge pointed out in its comments on EPA's revised smelter arsenic emission estimates that, since proposal, the arsenic feed rate to its Hidalgo smelter had decreased significantly due to a change in the smelter's source of copper ore concentrates. Since present concentrates contain only 0.001 to 0.005 percent arsenic (0.018 percent assumed at proposal), the arsenic input to the smelter now averages only 0.4 kg/h (0.9 lb/h), versus 14 kg/h (30.6 lb/h) assumed by EPA at proposal (IV-D-813).

Response: The EPA has revised its estimates of the arsenic emissions from the Hidalgo smelter based on the information submitted in Phelps Dodge's comments. The estimates EPA developed at proposal were based on earlier Phelps Dodge information, including the 0.018 percent arsenic content figure. In response to these latest comments, EPA has selected the midpoint of the suggested range of arsenic contents, or 0.003 percent, as an appropriate figure upon which to calculate new revised emission estimates. The resulting arsenic mass balance figure for Phelps Dodge-Hidalgo is shown as Figure B-12 in Appendix B. The new emission estimates were used in the exposure model to update the risk estimates; modeling input parameters are presented in Appendix C.

Table 4-1 presents the baseline converter secondary arsenic emissions estimated by EPA for low-arsenic smelters at the time of proposal, and current EPA estimates for these emissions revised as a result of public comments received by the Agency since proposal. All of the revised estimates are lower than the proposal figures, with the exception of the Kennecott-Hayden estimates, which are unchanged.

I-4.4 GENERAL COMMENT ON EMISSION ESTIMATES

Comment: The United Steelworkers of America (USWA) felt that no set of emission estimates should be considered final and definitive. The regulation should provide for a continuing examination of arsenic emissions from all sources at the smelters, in order to identify opportunities for additional control (IV-D-708).

Response: The EPA agrees with this commenter that estimations of emissions from a source should not be considered final, and that continuing examinations, as circumstances warrant, should be carried out in order to have up-to-date and accurate emission information on record. It was for this reason that the Agency's estimates at proposal were reevaluated subsequent to the receipt of public comments. Several emission estimates were revised to reflect new information on feed arsenic concentrations, smelter configurations, and process data (IV-B-32). Also, the estimates specifically for ASARCO-Tacoma were continuously revised and released to the public (IV-B-10, IV-C-120, IV-E-23). The final regulation was issued after considering the best information available. The regulation will be periodically reviewed after promulgation and changes made as appropriate to account for any new information relating to arsenic emission sources at primary copper smelters.

Table 4-1. EPA PROPOSAL AND REVISED BASELINE ARSENIC SECONDARY EMISSION ESTIMATES FOR CONVERTER OPERATIONS

Smelter	EPA Estimates of Baseline Secondary Emissions from Converters					
	Proposal Estimate			Revised Estimate		
	lb/h	kg/h	Mg/yr	lb/h	kg/h	Mg/yr
ASARCO-Hayden	7.7	3.5	30.1	1.3	0.60	5.4
ASARCO-El Paso[a]	7.0	3.2	27.5	3.4 0.9	1.5 0.40	13.3 3.4
Kennecott-Utah	2.0	0.90	8.0	0.4	0.20	1.5
Kennecott-Hayden	1.8	0.80	6.5	1.8	0.80	6.5
Kennecott-McGill	11.7	5.3	45.9	2.6	1.2	10.1
Phelps Dodge-Morenci	1.8	0.80	6.9	0.4	0.20	1.9
Phelps Dodge-Ajo	0.7	0.30	2.6	0.13	0.06	0.52
Phelps Dodge-Hidalgo	0.3	0.14	1.2	0.05	0.02	0.19

[a] The higher revised estimate for ASARCO-El Paso is based on assumption of an emission factor for uncontrolled converter fugitive emissions of 15 percent of the arsenic contained in the converter primary process gases. The lower revised estimate is based on assumption of a 3.75 percent emission factor. These two values are presented to assess the range of possible impacts; see Section I-4.1.2).

I-5.0 HEALTH RISK ASSESSMENT

Comment: Phelps Dodge, Kennecott, and ASARCO stated that Section 112 was intended to apply only when emissions pose a significant risk of increased mortality or serious irreversible, or incapacitating reversible illness. Phelps Dodge felt that the evidence presented to EPA has established that arsenic emissions from U.S. primary copper smelters do not present significant risks. The evidence that the companies presented in support of their position included the following: both community and certain occupational studies do not detect lung cancer risks associated with exposure levels at or greater than those occurring near primary copper smelters; and the smelter exposure levels are less than those found in some cities in the U.S. (IV-D-620, IV-D-634, IV-D-640).

Response: As discussed in "Inorganic Arsenic NESHAP: Responses to Public Comments on Health, Risk Assessment, and Risk Management" (EPA-450/5-85-001), the evidence examined by the Agency has not proven that primary copper smelters pose insignificant or nonexistent risk to the exposed public. (The commenters did not deny that arsenic exposure was occurring.) The community and occupational studies were cited to support the commenter's position, but these studies generally do not have the statistical power to detect significant increases in lung cancer at the exposure levels predicted by the Agency's models. Although they did not detect increases in risk, these studies could not conclude with a high degree of statistical confidence that risk increases were not present. By applying the best information available and using a scientifically creditable exposure/risk relationship that was based on occupational data, EPA has estimated (extrapolated) increased lung cancer risk to the public surrounding the smelters.

Another part of the companies' comments involved a comparison of the ambient concentrations caused by smelter emissions with the highest concentrations measured at other places in the U.S. According to EPA's estimates and data banks, the maximum concentrations to which people may be exposed near smelters range from about 0.01 to 1.0 $\mu g/m^3$, and the highest annual concentrations reliably reported in areas not affected by smelters were in Ohio and Atlanta, Georgia, at about 0.01 $\mu g/m^3$. This comparison indicates that arsenic concentrations in most areas are well below the predicted and measured concentrations near copper smelters.

In the Administrator's judgment, the primary copper smelters are posing significant risks, but in light of the magnitude of the estimated risks and the impacts of requiring further controls, most of those risks are not unreasonable.

Comment: Two commenters who had carefully studied EPA's risk assessment results criticized the fact that the computerized exposure model placed portions of exposed populations at points where people could not possibly live. For instance, in the Phelps Dodge-Ajo smelter analysis, people had been located in uninhabited areas near the smelter such as tailings ponds, slag heaps, and waste dumps (IV-D-640, IV-D-704a).

Response: The EPA is aware that the computer model can assign exposed people to unlikely places near a smelter. This is not a problem with the model, but occurs due to the format of the census data. Of necessity, the census data are provided to and used by EPA in a summary form so that the computer data storage capability is not overloaded. Instead of providing records on the location of each family dwelling, the census bureau gathers a number of people (up to 2,000 people) and locates this group of people at one point called a "population centroid." Of course, most of the people in the group do not actually dwell at this population centroid. The exposure computer program accounts for the fact that groups of people do not live at a single point and, using a preselected formula that more realistically reflects the actual population distribution, assigns people to nearby points on the concentration profile grid. Generally, this approach causes the model estimate of the risk to the most exposed person to increase, since "spreading out" the population over a broader area increases the likelihood that people will be placed nearer points of maximum concentration. After the HEM model has made the risk estimates, EPA staff review the computer printouts to insure that the estimation of the risk to, and the location of, the most exposed individual is reasonable. This judgment is based on a study of small scale U.S. Geological Survey (USGS) maps and discussions with Agency personnel who have visited the plants. In the calculation of annual incidence or aggregate risk for a large number of nearby people, such careful checking becomes very difficult. In cases where the Agency has attempted to make such corrections in the modeling, the results have not changed significantly. The reason for this is that the computer simply locates people in a more reasonable spot where the concentrations may be larger or smaller than at the original location. With larger populations, the corrections tend to result in about equal positive and negative changes to the estimated risks, and thus balance each other. With smaller populations, the Agency reviews the reasonableness of the exposure results and, where deemed necessary, makes corrections by hand calculations. Although somewhat disconcerting to several commenters, the Administrator believes that the risk assessment techniques used as a basis for today's rulemaking produce reasonable exposure and risk estimates, given all the other uncertainties that are associated with the risk assessment process.

Comment: One commenter noted that EPA assumed that indoor air arsenic concentrations equaled the ambient concentrations near a house, and felt that EPA's assumption probably causes overestimation of exposure and risk (IV-D-634).

Response: When developing inorganic arsenic exposure estimates, the Agency considered this possibility. If there are no sources or sinks for arsenic in a house, the long-term concentrations in the house should equal the concentrations measured just outside the house. However, this may not be true for some homes. For example, homes that have a filtered air handling system for heating and cooling would tend to have lower indoor arsenic concentrations. Little study has been made of the relationship between indoor and outdoor arsenic concentrations. The limited available data on total particulate matter indicate that the indoor concentrations are somewhat lower than ambient concentrations but the difference is not substantial; the indoor particulate matter levels are about 10 to 30 percent lower than in the outdoor air. Whether this ratio applies to homes near arsenic sources is unknown. Since people spend some amount of the time on their property outside the house and since the available data do not indicate that a correction for indoor arsenic concentrations is required, the assumption of equal arsenic concentrations for both indoor and outdoor air over a long term is reasonable, and probably leads to conservative health risk estimates. The EPA has not made any changes to its current analysis to account for this factor.

Comment and Response: Phelps Dodge stated that the location coordinates for its Ajo smelter that EPA presented in low-arsenic BID, Volume I are inaccurate (IV-D-640).

In response to this comment, EPA checked its location data on a small-scale USGS map and has made the location change (less than a kilometer shift in position). The current risk assessment is based on the new location data.

Comment and Response: Several of the primary copper smelter companies felt that EPA should present a table for each smelter that provides the distribution of levels of exposure. (The EPA only showed this information for all smelters as a group, not for individual smelters.) They said that without this information, the public is not able to check the accuracy of EPA's exposure assessment (IV-D-621, IV-D-640, IV-D-704a, IV-F-1).

As a result of these comments, EPA has expanded its risk assessment discussion for primary copper smelters and the other source categories (see Appendix C of this document) and has included in each docket copies of the exposure assessment computer printouts.

Comment: Several commenters criticized the appropriateness of the meteorological data EPA used in its dispersion modeling. One (IV-D-608) said EPA did not rely on accurate meteorological studies. Some commenters (IV-D-621, IV-D-640, IV-D-704, IV-F-1) said that, since the Tucson data used to model Phelps Dodge smelters in Ajo and Morenci, Arizona, were from a location over 160 km (100 miles) from these smelters, the data are not representative of meteorological conditions at the smelters. They suggested that local meteorological data be used. Another (IV-D-704) said the model, by using the Tucson data, estimates the highest concentrations to be to the northwest and west-northwest of the smelter. This commenter said data show Ajo's winds to be primarily from the south, so the highest concentrations should be directly north of the smelter. However, areas north of the smelter are largely uninhabited. These commenters believed that using the Tucson data caused overestimation of exposure. One commenter also felt that assumptions about atmospheric stability should be avoided, and instead that soundings should be taken at various heights to measure stability.

ASARCO (IV-D-620) also claimed that the Tucson data were not representative of their smelter at Hayden. ASARCO said Tucson was over 100 km (60 miles) from Hayden, and that Tucson is in a broad valley, whereas Hayden is mountainous with a narrow valley, so wind patterns would be different. ASARCO also commented that the El Paso smelter is on the other side of a ridge from the meteorological station whose data EPA used to model that smelter, so the data are not representative. They also cautioned that meteorological conditions at the elevation of a tall stack may be different from those at ground level. Kennecott also claimed that the Tucson airport is located too far from their Hayden smelter for the airport data to be representative of conditions at the smelter (IV-D-634).

Response: As discussed in Appendix C, since proposal EPA has made several efforts to improve its estimates of risks near primary copper smelters. However, only the analyses for three plant sites (El Paso, Douglas, and Garfield) were affected by the improvements. At the other primary copper smelter sites, the Agency was unable to obtain more representative meteorological data in a format that could be used by EPA's computer models. These other smelters are generally located in rather sparsely populated areas and are not near a National Weather Service station that collects and records the necessary surface weather observations. As the commenters point out, the selected surface weather observations (meteorological data) may not be entirely representative of the smelter area. In this case, the Agency must use the best available information to perform its analysis.

When the Agency has conducted site-specific analyses in the past, the more comprehensive analyses have not provided significant changes in the risk assessment results. In this case, the commenters suggested that the risks are overestimated. EPA's experience has shown that, when applying the more local or representative meteorological data, the risk estimates may either increase or decrease and because of the complexity of the dispersion and exposure models, the changes are difficult to predict in advance of completing the new computer analysis.

Comment: Several commenters (IV-D-620, IV-D-621, IV-D-640, IV-D-704a, IV-F-1) felt that EPA's dispersion model overestimates ambient arsenic concentrations. Some (IV-D-621, IV-D-640, IV-D-704a, IV-F-1) said EPA should have measured the background arsenic present when smelters were not operating and compared this with ambient arsenic concentrations measured when the smelters were operating to determine the extent to which smelters contribute to ambient arsenic levels. These commenters and others further felt that EPA should base its exposure estimates on measured ambient concentrations rather than dispersion model outputs (IV-D-620).

Some commenters presented ambient monitoring data and compared it to the dispersion model predictions in an attempt to show that the dispersion model is inaccurate. Phelps Dodge, for example, submitted ambient arsenic concentrations measured with a high-volume air sampler for two periods: January through April, 1982, and January through April, 1983. Measurements were taken at the Ajo town plaza. During the first period the Ajo smelter was operating normally, while during the second period it was closed. These data were used to arrive at an estimate of 0.0014 $\mu g/m^3$ as the level of ambient arsenic concentration at the plaza caused by the smelter. The commenter said that EPA's model estimated maximum ambient concentrations 150 times greater, and average exposures 40 times greater, than these measured concentrations (IV-D-640, IV-D-704a).

Some commenters claimed that ambient arsenic levels in the town of Morenci are only 10 percent of the levels reported by EPA in the proposal notice (IV-D-640, IV-F-1). ASARCO submitted quarterly concentrations of arsenic measured by the company's low-volume air sampling network around El Paso and Hayden in 1982 and 1983, and said the mean measured concentration at the Hayden fire station (near the town's population center) is 0.14 $\mu g/m^3$. According to ASARCO, this measurement should be multiplied by 1.67 (yielding a value of 0.23 $\mu g/m^3$) to produce an estimate similar to that which would be obtained using a high-volume air sampler. ASARCO pointed out that EPA's dispersion model estimates a concentration of about 0.417 $\mu g/m^3$ for this location, which is nearly twice as high as the adjusted measured concentration (IV-D-620).

Some commenters (IV-D-620, IV-D-640) criticized EPA's dispersion model because it does not consider the effects of terrain. They said the terrain is not level around copper smelters, in particular Phelps Dodge's Ajo smelter and ASARCO's Hayden and El Paso smelters. One commenter added that EPA's background document for the proposed standard states that failure of the model to consider terrain will result in underestimation of exposure in areas with uneven terrain. The commenter said this is not always the case. He said measured concentrations in Hayden were lower than modeled concentrations (IV-D-620).

Response: In response to these comments, EPA has made several changes to improve or check its exposure and risk estimates. (See Appendix C for a detailed presentation of the current risk assessment.) In addition to significantly reducing some of the smelters' emission estimates (e.g., Phelps Dodge-Morenci and Phelps Dodge-Ajo), comparisons between predicted and measured values have been made to demonstrate the exposure model's potential for accurately estimating ambient concentrations. Since it generally does not provide a site-specific analysis that accounts for local terrain features and meteorology and because there are other sources that emit arsenic into the atmosphere, the exposure model will likely both over- and underpredict measured concentrations; but, on the average, the model should slightly underpredict the measured values. As a result of a computer data base search, limited ambient arsenic data near the ASARCO-Hayden, Inspiration-Miami, Magma-San Manuel, Phelps Dodge-Ajo, Phelps Dodge-Morenci, and Phelps-Douglas sites were identified, while for the ASARCO-El Paso site the Agency located a number of arsenic monitoring sites operated by the State Agency and ASARCO.

For El Paso, EPA's computer exposure model consistently underpredicted concentrations at 20 monitoring sites (including six company sites). At eight of these sites, the predicted concentrations were within a factor of two of the measured data and all but one of the remaining estimates were within a factor of ten of the measured data. At the one remaining site, EPA had underestimated the arsenic concentration by a factor of 40. (However, the data at this one site were collected in one year only and did not meet the air quality guidelines for calculating a representative annual average.) The amount by which EPA's exposure model underpredicted the measured concentrations was higher than what EPA would consider a natural background concentration. In an attempt to improve the correlation between predicted and measured concentrations, EPA also performed a site-specific analysis of El Paso. This site-specific analysis used on-site meteorology and considered terrain features. The site-specific analysis also provided predicted concentrations that were lower than the measured concentrations. There are three possible explanations for this underprediction. First, as the commenters have suggested, there is some fraction of the arsenic concentration that comes from other sources, such as naturally occurring arsenic in the local soil. Second, studies have shown that pollution from past plant emissions has increased pollutant concentrations in the surrounding soil and this condition allows the reentrainment of arsenic into the atmosphere. Third, the Agency may have underestimated current emissions from the plant. Some combination of reentrainment of local soil and underestimation of the plant's emissions is the suspected but undocumented cause of the underpredictions.

At the ASARCO-Hayden and Phelps Dodge-Douglas primary copper smelter sites, EPA's analysis indicated that the exposure model both over- and underpredicted the measured concentrations at those monitoring sites where meaningful comparisons could be made between predicted and measured concentrations. However, at the State-operated monitors near the smelters, the calculated long-term concentrations were often based on individual measurements that were below the minimum detectable level (MDL) of the analysis technique. Rather than record zeros, EPA assumed that the actual concentration is one-half of the MDL and used that value in the analysis. Thus, when there are a number of measured concentrations below the MDL in the data base, the calculated long-term concentration becomes more uncertain. When the Agency considered this uncertainty in the available ambient data at the Phelps Dodge-Douglas and ASARCO-Hayden sites, it appeared that the exposure model was making a reasonable estimate if not somewhat of an overprediction of the ambient concentrations.

At the remaining primary copper smelter sites (Inspiration-Miami, Phelps Dodge-Ajo, Phelps Dodge-Morenci, and Magma-San Manuel), much of the ambient data showed concentrations below the MDL and, at best, provided only a qualitative comparison to confirm the model's predicted concentrations. At the Phelps Dodge-Douglas site, EPA performed an additional site-specific analysis similar to the one performed for the ASARCO-El Paso site. Although the Agency believes that the site-specific analysis will generally produce at any site the best estimate of ambient concentrations that occur as a result of a source's emissions, EPA's human exposure model provides ambient concentration estimates that are very similar to the site-specific analysis results and the available ambient data. (See Appendix C for a detailed discussion of the modeling.)

There were several primary copper smelter sites for which no nearby ambient data could be found. When considering the results of the model confirmation efforts described above, the Administrator believes that the ambient concentration estimates generated by HEM are reasonable and represent the best estimates that can be provided within the limited resources available.

Comment: Several commenters said that some populations are exposed to emissions from two or more smelters. They reasoned that since the model does not consider the combined effects of the emissions from plants with overlapping emissions, exposure and risk are underestimated. This possibility could occur with respect to the Hayden area since two primary copper smelters (owned by ASARCO and Kennecott) are located in this town. In this case, there is a potential for the risk assessment to underestimate the maximum individual risk (IV-D-608, IV-D-626, IV-F-1).

Response: The EPA checked the predicted locations where the maximum individual risk occurs and added the risk (predicted concentrations) due to the other plant's emissions to the single plant risk value. This procedure was used for both plants and the larger value from those two calculations was then compared to the largest maximum individual risk calculated in either single source analysis. Since the ASARCO-Hayden facility emissions dominate the concentrations, the additional risk (concentration) from Kennecott-Hayden has been shown to be small, about 16 percent of the ASARCO-Hayden maximum individual risk. The commenters have made a valid point, but the maximum individual risk estimates that account for the overlapping of the ambient concentrations are essentially the same as the maximum individual risk based on only the ASARCO-Hayden emissions. The Agency also modified the exposure model and estimated the risk associated with the combination of the two plants. The model substantiated the earlier estimates. For the annual incidence, the combined smelter exposure assessment indicated that the town of Hayden's annual incidence is simply the sum of the annual incidence associated with each plant's operations.

Comment: Some commenters said that primary copper smelter risks were overestimated because EPA has applied a number of conservative assumptions that lead to worst-case risk estimates (IV-D-617, IV-D-640, IV-D-704, IV-F-1).

Response: The EPA agrees with the commenters that some of the Agency's assumptions are conservative (e.g., that the exposed people remain at their residences for a lifetime). However, in several cases, the assumptions are generally not conservative. For example, the assumption of flat terrain may result in underprediction of ambient concentrations for those sources located in areas with local terrain features elevated above the source. Upon review of the assumptions and their associated uncertainties, the Agency cannot determine whether the inorganic arsenic analysis methodology is conservative, a best estimate, or an underestimate of actual risks. Although not able to quantify all the uncertainties, the Agency believes that its risk assessment provides reasonable, if not somewhat conservative, estimates and that these estimates are the best that the Agency can reasonably make. A number of commenters have made suggestions for improving the risk estimates as was mentioned in earlier comments. The EPA has followed their suggestions where feasible (e.g., use of nearby ambient data to confirm the exposure model's prediction).

Two smelter companies made their own risk calculations, which they believed to be more accurate than those EPA presented in the low-arsenic BID for the proposed standard. Their results are summarized in Table 5-1. At two sites (Hayden and McGill), EPA's estimated risks are very similar to those estimated by the companies. At the two remaining sites (Garfield and Ajo), there was substantially less agreement. The footnotes to the table explain the reasons for the differences in results. Since EPA has decided not to regulate any of these four smelters, the companies' lower risk estimates have no effect on the Administrator's final decisions.

Comment: Phelps Dodge and Boliden Metall of Sweden requested that EPA delay promulgation of the standard until the upcoming epidemiological studies by Higgins and Enterline are released, in keeping with EPA's obligation and commitment to base its regulatory decisions on the most current scientific information as revealed in the record. The public should then be given a chance to comment on this latest arsenic health risk information (IV-D-616, IV-D-640). The United Steelworkers of America (USWA) criticized the preliminary unpublished findings from this study, noting that the Higgins finding concerning a possible "ceiling" arsenic concentration level below which there is no risk of excess lung cancer mortality has no statistical significance. USWA also referred to OSHA's criticisms that the study used only a small subsample of the available cohort and that problems exist with the study methodology and the hypothesis that lung cancer risk depends on the highest 30-day dose, rather than the cumulative dose (IV-D-708).

Response: Section 112(b)(1)(B) of the Clean Air Act specifies that emission standards for hazardous air pollutants must be promulgated no more than 180 days after such standards are proposed by the Administrator. The EPA must show good cause for delay if this deadline is not met. In the case of the standard for the primary copper smelters, promulgation of the standard was delayed to allow additional time for public input to the standards development process. The period of public comment on the proposed standards was extended and then reopened such that it ended 195 days after proposal. Public comments on EPA's revised arsenic emission and control cost estimates after proposal were solicited by the Agency in a separate Federal Register notice dated September 20, 1984 (see Section I-1.0, Summary). The Agency believes it provided adequate time for commenters to submit information to the record. Information submitted to the record included discussion of the Higgins and Enterline studies (II-J-13). These studies address the issue of whether there is a "threshold" for exposure to airborne inorganic arsenic, below which there are minimal adverse health impacts for humans.

In developing proposed standards for sources of inorganic arsenic, EPA took the position, shared by other Federal regulatory agencies, that there is no threshold below which arsenic exposure poses no cancer risk (see Section C.1.2). The Agency feels this position is reasonable, considering the available information and the fact that public health is at stake. If it were anticipated that there was a good chance of these new analyses conclusively refuting the no-theshold assumption, this would provide good cause for additional delay in promulgating the final standards. However, EPA does not foresee that the results of

Table 5-1. COMPARISON OF RISK ESTIMATES MADE BY THE SMELTER COMPANIES AND EPA

Smelter	Baseline - Maximum Individual Lifetime Risk		Baseline - Annual Incidence (Cases/yr)	
	Company	EPA	Company	EPA
Phelps Dodge-Ajo[a]	0-6 x 10^{-6}	2 x 10^{-4}	0-0.00044	0.0045
Kennecott-Garfield[b]	0.8-5.0 x 10^{-6}	6 x 10^{-5}	0.0006-0.003	0.14
Kennecott-Hayden	4.5-27 x 10^{-4}	3 x 10^{-4}	0.0017-0.025	0.016
Kennecott-McGill	1.7-13 x 10^{-3}	4 x 10^{-4}	0.005-0.1	0.006

(a) Phelps Dodge's analysis was based on limited sampling data collected over 3 months at one site that was located approximately 1 km from the Ajo plant. The EPA's analysis was based on air dispersion models that estimate long-term (over several years) concentrations. Based on the company's analysis, EPA's exposure model is substantially overpredicting ambient concentrations.

(b) The EPA's risk analysis considered population exposure out to 50 km while Kennecott's analysis went out to 20 km. There are a significant number of people that live between 20 and 50 km from the plant. This factor may account for the difference between EPA's and Kennecott's estimates for annual incidence. The reason for the difference in the maximum individual risk estimates is unknown.

this single study will provide such a refutation. Therefore, it was not considered in the public interest to delay promulgation while the study results were being prepared for release. New scientific information related to the health effects of arsenic will be considered in future reviews of the standard for inorganic arsenic.

I-6.0 EMISSION CONTROL TECHNOLOGY

I-6.1 SELECTION OF BEST AVAILABLE TECHNOLOGY (BAT) FOR SPECIFIC SMELTERS

I-6.1.1 BAT for Converter Operations at Kennecott-Utah

Comment: Kennecott maintained that EPA's specification at proposal of best available technology as air curtain secondary hoods for converter fugitive emissions conflicts with the previous BAT determination made for the Kennecott-Utah smelter that was included in the Utah State regulations. In 1978, Kennecott installed primary and secondary hooding, ceiling vents, fans, and ductwork in order to comply with these regulations. The proposed NESHAP would require that the existing secondary hoods be torn out and that air curtain hoods be installed in their place. The company maintained that to redefine BAT in this way would amount to a punishment of Kennecott for having in good faith installed BAT, as then defined, in 1978. Kennecott feels it is possible that air curtain secondary hoods would not be as efficient at Kennecott-Utah as the present system, and in fact may not be as efficient at this smelter as they are at the ASARCO-Tacoma smelter. BAT should not be specified so precisely when several approaches to capture are available (IV-D-634).

Response: The EPA's selection of air curtain secondary hoods as representing best emission controls on converter arsenic secondary emissions does not conflict with previous control determinations made in connection with State plans. In the case of Kennecott's Utah smelter, regulations were imposed in 1978 by the State in order to control emissions of SO_2 and particulate matter (PM). These controls were considered to represent reasonably available control technology (RACT) for limiting emissions of these pollutants. The purpose of the controls was to reduce the smelter's contribution to ambient levels of these two criteria pollutants so that the national ambient standards could be attained in the local region.

The controls specified in this NESHAP proposal were developed under separate authority and for another purpose, and thus do not constitute a redefinition of previous controls developed for copper smelters. In the time period since RACT controls on SO_2 and PM were installed at the Utah smelter, EPA has listed inorganic arsenic as a hazardous air pollutant and primary copper smelters have been determined to contribute significant quantities of this pollutant to the ambient air. The Agency believes that, in order to limit inorganic arsenic emissions from smelters to the maximum degree possible, the strictest controls (referred to now as the best emission controls, and not BAT) should be applied to sources that pose a significant health risk to communities. The application of these controls to a specific source is determined following an analysis of expected emission reduction, health risk, and the cost of controls. Therefore, controls are imposed where significant benefit can be derived and where the costs are considered reasonable.

Air curtain secondary hoods were specified to control converters because these are the best emission controls demonstrated to EPA. Other control approaches, if shown to control inorganic arsenic to an equivalent degree, would also be acceptable under the standard (see Section I-6.3). In the case of the Kennecott-Utah smelter, EPA's analysis showed that application of air curtain secondary hoods would not achieve any reduction in risks; hence, it is expected that this smelter will not be required to install air curtain secondary hoods to comply with the standard.

I-6.1.2 BAT for Converter Operations at ASARCO Smelters

Comment: ASARCO made a similar comment to that of Kennecott in objecting to the requirement to install air curtain secondary hoods on the converters at the company's Hayden smelter. The existing secondary hoods at ASARCO-Hayden were installed less than 4 years ago at a cost of $4.4 million. These fugitive emission controls at that time were considered the best controls available. ASARCO believes that air curtain secondary hoods installed at Hayden would be significantly less efficient than the prototype air curtain hood at ASARCO-Tacoma, because the dimensions of the Hayden hoods would necessarily be smaller (see Section I-8.1.1.1). Further, the existing secondary hoods at Hayden may be more effective than air curtain hoods would be at this smelter (IV-D-620). The company repeated these comments pertaining to control requirements for its Hayden smelter following EPA's release of its revised arsenic emission and control cost estimates (IV-D-811).

Although ASARCO also objects to any requirement for air curtain secondary hoods at its El Paso smelter, the company would consider installing these controls, which would reduce fugitive emissions and help meet OSHA requirements through improved workplace conditions. The company stipulated that, before this decision could be finalized, EPA must make final its general design criteria for secondary hoods and the State of Texas Air Control Board must revise the SO_2 and opacity limitations on emission points that would be affected by these converter fugitive emission controls.

ASARCO does not oppose the requirement for matte and slag tapping controls (hood capture followed by collection) at its Hayden and El Paso smelters, because it has already begun these conversions or has made plans to do so (IV-D-620).

Response: The response to this comment is similar to the response in Section I-6.1.1. The existing secondary hoods at ASARCO-Hayden were not installed to control secondary emissions of arsenic from converter operations, but to control SO_2 and particulate emissions. Therefore, the secondary controls installed 4 years ago at the Hayden smelter were not then considered, nor can they now be considered, to represent the best emission control for inorganic arsenic that escapes capture by the converter primary hoods. Further, these secondary hoods are not designed to capture fugitive emissions while the converters are rolled out for charging, skimming, or pouring operations. The only fugitive emissions captured are the secondary emissions generated due to leaks in the primary hood occurring while the primary hood covers the converter mouth during blowing periods. Since the significant level of fugitive arsenic emissions generated during roll-out activities is not addressed by the current control system on the converters at ASARCO-Hayden, further control may be necessary to reduce public health risk due to these emissions.

There is no requirement in the regulation for air curtain secondary hoods installed on converters at a regulated smelter to achieve the same performance levels as the prototype air curtain installation at the Tacoma smelter. The requirement in §61.172(b)(2) is for the owner or operator to operate the converter and secondary control system such that capture of secondary inorganic arsenic emissions is optimized. This ensures that the particular installation will achieve the best performance possible.

ASARCO further has the opportunity under the equivalency provisions of the Act to demonstrate to the Administrator that the current system can provide a degree of emission capture, and hence public health protection, that is equivalent to the best emission controls. As discussed in the response made to another ASARCO comment (see Section I-6.3), the equivalency provisions allow the Administrator to use discretion in the consideration of plant-specific factors. An example of such a factor is the narrow converter aisle at Hayden, which necessitates a different hood design than the design used at Tacoma.

I-6.1.3 BAT for Furnace Process Emissions at ASARCO-El Paso

Comment: NRDC questioned EPA's determination (at 48 FR 33139) that the cold ESP controlling furnace process emissions at ASARCO-El Paso represents the best control on this source, since its inorganic arsenic removal efficiency is approximately 96 percent. Since ESP's are capable of achieving 99 percent removal, and baghouses can achieve 99.5 percent, how can the existing system be considered an adequate representation of the best emission control (IV-D-710)?

Response: The preamble to the proposed standard (at 48 FR 33139) states that the smelting furnace offgases at ASARCO-El Paso are cooled to about 105°C (220°F) before entering the ESP, and that the average inorganic arsenic concentration in the cooled inlet gas stream (0.308 g/m^3) greatly exceeds the arsenic saturation concentration at 105°C (0.008 g/m^3). Under these conditions, the arsenic in the gas stream is essentially all in the particulate state and available for collection in the ESP. The EPA judged this control system (spray chamber/ESP) to be properly operated and maintained. Table 3-10 in proposal BID shows control efficiencies for arsenic collection measured in three sample runs made in 1977 to be 95.6, 97.2, and 98.8 percent. A judgment was made concerning the level of control this system could achieve continuously. The lowest of the three measured efficiencies was selected to represent the continuous performance of this cold ESP (96 percent).

In making the determination that the system controlling furnace arsenic emissions at ASARCO-El Paso represents the best control available, EPA considered the economic feasibility of replacing this system with respect to the potential additional emission reduction that might be achieved. Additional gas stream cooling measures would not likely increase the amount of inorganic arsenic in particulate form and thus available for collection in the ESP. Further, it would not be reasonable to require the installation of another ESP in place of the existing ESP because the collection efficiency of the same type of control device would not likely be significantly greater than the current control levels. To install a baghouse downstream of the spray chamber also would not be reasonable because the cost would be disproportionate to the emission reduction that could be obtained. Due to these considerations, the existing spray chamber/ESP combination was considered at proposal to represent the most advanced level of control for its specific application, considering economic feasibility, at the ASARCO-El Paso smelter. Should future EPA reviews of this standard or of test data conclude that additional emission reduction benefits are achievable on this gas stream, this determination of best controls will be reconsidered.

I-6.1.4 BAT for Furnace Process Emissions at Phelps Dodge-Ajo

Comment: Phelps Dodge commented that EPA should not consider the cooling of reverberatory furnace offgases as an option for control of inorganic arsenic emissions at the Phelps Dodge-Ajo smelter. [Note: EPA had discussed in the preamble to the proposed standard (48 FR 33140) the possibility of including in the final standard emission limits on process offgas streams at certain smelters in the event that controls expected to be installed under SIP consent decrees were not installed. In particular, four smelters, including Phelps Dodge-Ajo, were intending to install controls on process emission sources under existing consent decrees. However, at the time of proposal, there was some uncertainty regarding the final form of the consent decree for the Ajo smelter. The EPA stated that if this smelter's consent decree did not bring about sufficient process control of the smelting furnace offgases, a requirement for cooling the offgases prior to control would be considered under the final regulation. This measure would allow increased collection of particulate arsenic in the existing ESP.]

The principal reasons the exercise of this option is felt by the commenter to be inadvisable are: (1) the suggested temperature of the cooled gas stream (121°C, or 250°F) is below the acid dew point, which would lead to equipment damage; (2) controls under the renegotiated consent decree would bring the smelter into compliance with existing particulate standards; and (3) stack gas reheating equipment would have to be installed to make stack dispersion possible. Phelps Dodge also thought that the costs of implementing this control option would be prohibitive (see Section I-8.1.3.2).

This commenter stated that there is little documentation to demonstrate that gas cooling would significantly increase the arsenic collection efficiency of a particulate control device. In addition, tests on the ESP at Ajo (controlling offgases from the reverberatory furnace) show an efficiency of about 60 percent, in contrast to EPA's prediction of 30 percent based on the gas stream temperature. This confirms the uncertainty involved in predicting arsenic collection efficiency based on the temperature of the gas stream (IV-D-640).

Response: In order to evaluate the contentions of Phelps Dodge regarding the technical and cost issues related to process arsenic controls at the Ajo smelter, EPA after proposal requested that the company supply additional information to clarify and support its claims (IV-C-417). In two separate responses, Phelps Dodge addressed the issues of gas stream acid dew point (IV-D-785) and the estimated costs of arsenic controls for the Ajo smelter's reverberatory furnace (IV-D-790). The control cost issue has been addressed by the Agency in Section I-8.1.3.2. This response will discuss process controls from the standpoint of technical feasibility.

The company's principal technical objection to EPA's discussion of gas stream cooling concerned the Agency's selection of 121°C (250°F) as the final cooled gas temperature for the purpose of the analysis. Phelps Dodge commented that acid dew points encountered in process gas streams are higher than 149°C (300°F). To demonstrate this point, Phelps Dodge supplied two measurements of acid dew point, in the roaster-reverberatory stack at its Douglas smelter, of 148 and 152°C (298 and 306°F). The company also submitted a plot showing the rate of acid buildup in the gas stream versus detector temperature that indicates that at 163°C (325°F), the rate of acid buildup is essentially zero in the process stream at Douglas.

The EPA reviewed the information submitted by Phelps Dodge and agrees that cooling of process offgasses to 121°C (250°F) at some smelters could result in corrosion problems, if the data submitted are accurate. However, the EPA does not agree with the commenter that offgas streams in all smelters necessarily have acid dew points of at least 149°C (300°F). In particular, ASARCO-El Paso does and the ASARCO-Tacoma and Anaconda smelters did, prior to their closures, treat furnace offgas streams in dry control devices at temperatures of 90 to 110°C (190 to 230°F) (BID, Vol. I) without corrosion problems (A-80-40/IV-E-81). Since the acid dewpoint of a gas stream depends on the SO_3 concentration and the water vapor concentration, the acid dewpoint can vary among facilities due to differences in operations and conditions. Therefore, without considerable further investigation and analysis, EPA cannot determine whether the dewpoint of offgases at Ajo are closer to 121°C (250°F) or 149°C (300°F). Because the risk posed by furnace process emissions at Ajo are now estimated to be very low and because significant additional control would not be achieved by cooling to 121°C (250°F), such an investigation was not conducted.

At proposal, EPA assumed a baseline process configuration for the Ajo smelter that included, pursuant to the terms of a consent decree between Phelps Dodge and EPA, a reverberatory furnace modified to oxy-sprinkle smelting. The EPA considered gas stream cooling for the possible case where this furnace conversion was not carried out. It was estimated that 55 percent of the 59.5 kg/h (131 lb/h) furnace arsenic input, or 32.7 kg/h (72 lb/h), would volatilize from the reverberatory furnace charge into the process offgases. The concentration of inorganic arsenic in the process gas stream would thus be about 32.7 kg/h (72 lb/h in a gas flow of 3960 acmm (140,000 acfm) (at 315°C, or 600°F)), or 0.137 g/m^3. Since the arsenic saturation concentration at this gas stream temperature is about 560 g/m^3, very little arsenic collection was predicted for the hot ESP currently controlling Ajo's reverberatory furnace particulate emissions. However, in a gas stream cooled to 121°C (250°F), the concentration of inorganic arsenic would increase to about 0.205 g/m^3. Since the saturation concentration at this temperature is only 0.035 g/m^3, the difference of $(0.205 - 0.035)\ g/m^3 = 0.170\ g/m^3$, or 83 percent of the inorganic arsenic in the gas stream, potentially would be available for collection in the ESP (equivalent to 27.1 kg/h [59.7 lb/h] available for collection). If the ESP collected particulate matter at 96 percent efficiency, then gas stream cooling would be predicted to reduce inorganic arsenic emissions from 32.7 to 6.7 kg/h (72 to 14.7 lb/h), or 80 percent.

As discussed in Section I-2.3.3.2 of this document, EPA's estimate at proposal of 59.5 kg/h (131 lb/h) total arsenic input to the reverberatory furnace has been revised to 3.9 kg/h (8.6 lb/h) based on information supplied since proposal by Phelps Dodge. The furnace would now volatilize 55 percent of 3.9 kg/h (8.6 lb/h), or 2.1 kg/h (4.7 lb/h) (see Figure B-10 in Appendix B). In this case, the concentration of inorganic arsenic in the hot (316°C) furnace offgases would be about 0.009 g/m^3. Cooling of the gas stream to 110°C (230°F) would increase the concentration to 0.0136 g/m^3, which is only slightly greater than the saturation concentration (0.011 g/m^3). Furthermore, it would be necessary to cool the gas stream to below the dewpoint of water, and thus below the acid dewpoint, to condense a significant portion of the arsenic.

As discussed in the response to the next comment on gas stream cooling (Section I-6.2), an examination of the current risk posed by furnace process emissions at Phelps Dodge-Ajo shows it to be very low at 0.0034 cancer incidence per year. From the standpoint of risk reduction, then, a requirement for gas stream cooling to effect additional arsenic collection (even if all the arsenic present could be collected) would not bring about a significant reduction in health risk. Based on these considerations, EPA has determined that, in view of the revised values for furnace arsenic feed rate, as well as the very small potential risk reduction possible, this control option should not be specified at this time for the Phelps Dodge-Ajo smelter.

To support their argument that temperature of the control device is a poor indicator of arsenic collectability, Phelps Dodge submitted a summary of removal efficiencies determined in emission testing of two ESP's. These data showed arsenic collection efficiencies of about 50 to 96 percent at 246°C (475°F) and 96 to 99.5 percent at 188°C (370°F). The commenter stated that the reported efficiencies were based on concentration measurements alone, and acknowledged that accurate flow measurements were difficult because of sample port locations relative to flow disturbances. The EPA reviewed the material submitted and found the following deficiencies. First, the information provided was inadequate to allow review of the test procedures and assessment of the accuracy of the results. Second, the information provided indicated that many of the tests were nonisokinetic and, thus, are likely to be unacceptable. Consequently, the submitted data were judged by EPA to be insufficient to support the argument that temperature of the control device is a poor indicator of arsenic collectability.

I-6.2 FURNACE OFFGAS COOLING AS A CONTROL OPTION

Comment: The NRDC disagreed with many of EPA's determinations regarding the potential of gas stream cooling as a control measure on process gas streams at several primary copper smelters. This control option was not specified for these smelters in the proposed standard because it would likely require cooling the gas streams below 121°C (230°F), resulting in the need for corrosion resistance measures that would be very costly in relation to the amount of arsenic emission reduction achievable. In connection with these determinations, the commenter made three points. First, EPA's reliance on arsenic vapor pressure data for predicting the feasibility of collecting inorganic arsenic from a gas stream is unsupported because the theory and available test data are not in agreement. Available test data cited by NRDC in support of this assertion included (1) test data reported in the BID (p. 3-7) that demonstrates a 30 percent arsenic collection efficiency was achieved by a hot ESP for which no arsenic collection would be predicted based on vapor pressure of arsenic at the ESP's operating temperature of 315°C (559°F) and (2) data discussed in the portion of the proposal preamble concerning glass manufacturing plants (48 FR 33154) that indicate appreciable (>90%) arsenic control was achieved by an ESP and a fabric filter applied to glass furnace offgas streams where no achievable collection is predicted based on arsenic trioxide vapor pressure. It was suggested that EPA thoroughly examine this issue and attempt to reconcile the data and theory.

Second, evidence from emission tests performed at several copper smelters suggests that the acid dewpoint(s) of smelter offgases may be lower than 100-110°C (212-230°F). Thus, EPA's conclusion that cooling below 121°C (230°F) would require the use of corrosion resistant materials in control devices is not supported. Third, there is no discussion in the BID on the technical feasibility and cost of using corrosion resistant materials for control devices which would permit operating the control device at lower gas stream temperatures and, thus, achieving additional arsenic control. Smelters cited as candidates for reanalysis of the feasibility of controlling process gas streams through cooling followed by collection include: the roaster stream at Phelps Dodge-Douglas; smelting furnace streams at Kennecott-Hayden, Magma-San Manuel, Kennecott-McGill, Phelps Dodge-Douglas, and Copper Range-White Pine; and converter process streams at Phelps Dodge-Douglas and Copper Range-White Pine (IV-D-710, IV-D-810).

The NRDC felt generally that numerous opportunities for arsenic control at primary copper smelters had been overlooked in the proposal, and that the technology considered to represent best control is generally well below that already in use or reasonably available (IV-D-710, IV-F-1).

Response: After considering the specific points made by the commenter, EPA reexamined the potential use of gas cooling as a control measure. Based on these reviews, EPA concluded that (1) arsenolite vapor pressure data are useful for predicting the collectability of arsenic emissions from copper smelters and (2) additional control of process emissions by gas cooling should not be required. The bases for these conclusions are summarized below:

The EPA reviewed the data cited by NRDC and concluded that the data do not demonstrate any need to reconcile theory and data. Specifically, the collection efficiency achieved by the hot ESP is not surprising because, as was noted in the BID (p. 3-7), arsenic compounds other than arsenic trioxide may be present; and there are mechanisms other than condensation (e.g., adsorption) by which arsenic trioxide may be present as particulate matter and, hence, collected. Although not stated in the BID, it is likely that the 30 percent collection efficiency achieved by the hot ESP reflects the collection of arsenic bound in the ore concentrate matrix rather than the collection of condensed arsenic trioxide. Entrained concentrate is not unexpected in this gas stream because the ESP treats offgases from a reverberatory smelting furnace, the charging of which produces substantial quantities of particulate emissions. Thus, the observed efficiency is thought to reflect collection of other forms of arsenic. Furthermore, the observation of greater than predicted collection efficiency does not disprove the validity of using arsenolite vapor pressure data to predict the potential for additional emission reduction from gas cooling. Specifically, the contention that temperature has a significant effect on the collectability of arsenic is supported by test data on the subject ESP and by test data for other smelters. Emission sampling using in-stack filters (315°C [600°F)] followed by an out-of-stack filter (121°C [250°F]) showed condensation of arsenic trioxide as predicted from vapor pressure considerations (II-A-14, p. 51). In addition, review of test data presented in the BID shows outlet arsenic concentrations for four control devices that operate at reduced temperatures to be consistent with predicted concentrations.

The collection efficiencies observed for inorganic arsenic emissions from glass manufacturing plants are not considered predictive of collection efficiencies for copper smelter emissions. As previously noted, evidence from copper smelters clearly demonstrates that arsenic is present predominantly as arsenic trioxide (II-A-14, p. 51). The lack of correlation between emission control and temperature at glass plants suggests that the inorganic arsenic present is not in the form of arsenic trioxide.

The dewpoint data referred to by NRDC in its comment were for three smelters operating control devices at 90-110°C (190-230°F). These smelters were treating either a combination of process and fugitive offgas streams or highly diluted process offgas streams in the control devices, and the combined streams had very low SO_2 concentrations. Therefore, EPA sees no basis for concluding, in general, that cooling of process offgases to 100-110°C (212-230°F) or lower is reasonable. Cooling of the gas stream to 121°C (250°F) was assumed in the analysis because it was believed to represent a reasonable estimate of operating temperatures for primary copper smelter's process gas streams; although, it was also recognized that acid dew points may be higher or lower than 121°C (250°F) at some facilities. An additional consideration was that below 125°C (260°F), saturation concentrations are very small and further cooling would achieve very little additional emission reduction. Since no significant emission reductions were expected, EPA did not evaluate the feasibility and costs of process controls for these smelters.

Following proposal, because of the comments on the approach used, EPA assessed the maximum potential risk reduction achievable by control of these emission sources. For this second assessment, the revised smelter arsenic balances were used to predict arsenic emissions from process streams, and it was assumed that 100 percent of the arsenic would be controlled (i.e., the risk was reduced to zero). The EPA estimated the health risks associated with process emissions at all primary copper smelters where gas cooling could potentially be applied to reduced inorganic arsenic emissions from one or more process streams. Table 6-1 lists the smelters and process streams considered in this analysis. These smelters include the smelters for which gas cooling was evaluated as a control option at proposal plus Phelps Dodge-Ajo. The health risk estimates were prepared using HEM, and are summarized in Table 6-2.

The EPA has also estimated preliminary annual costs associated with process stream gas cooling. For the purpose of these estimates, it was assumed that gas stream cooling to 121°C (250°F) or below could be achieved without requiring that special measures be taken to prevent corrosion problems. It was also assumed that for process streams at all smelters except Kennecott-McGill, where converter process emissions are currently controlled with multicyclones, and Copper Range-White Pine, where converter process emissions are currently uncontrolled, existing particulate collectors would not have to be replaced. For Kennecott-McGill and Copper Range-White Pine, the estimates include the annualized cost of a new particulate collector in addition to the cost of gas cooling for the converter streams. In addition, for all smelters the estimates include the cost of reheating the gas streams back to their original temperatures (current temperatures without cooling). The annualized cost estimates are shown in Table 6-3. It is important to note that these costs are very preliminary and may not accurately reflect the true cost of applying gas cooling. However, EPA believes these estimates do give a general indication of the relative magnitude of the costs of applying gas cooling as a control option.

As can be seen from Table 6-2, the annual incidence associated with the process emission streams to which gas cooling could potentially be applied is very low in all cases, with 0.0036 incidence per year being the highest. Thus, even if gas cooling could reduce process stream emissions by 100 percent, the reduction in risk would be very small. In addition, the cost of achieving this small reduction in risk could be significant, as shown in Table 6-3. These considerations led EPA to conclude that even if gas cooling to 121°C (250°F) or below were a feasible control option for process emissions at these smelters, the costs would be greatly disproportionate to the very small reduction in risk that could be achieved, and therefore gas cooling should not be included among the control requirements of this NESHAP.

Comment: The State of New York stated that EPA had not adequately considered the physical behavior of arsenic trioxide (As_2O_3) in the Agency's analysis of the collectability of gas stream arsenic. This commenter discussed the special control problems resulting from the manner in which arsenic sublimes and condenses as the temperature or arsenic concentration changes. Since As_2O_3 condenses more slowly than

Table 6-1. CURRENT CONTROL STATUS OF SMELTER PROCESS STREAMS WHERE COOLING COULD POTENTIALLY BE APPLIED

Smelter	Process Stream(s)	Current Control	Gas Stream Temperature (°C)
Kennecott-Hayden	Smelting Furnaces	ESP	260
Magma-San Manuel	Smelting Furnaces	ESP	260
Kennecott-McGill	Smelting Furnaces	ESP	316
	Converters	Multicyclones	427
Phelps Dodge-Douglas	Roasters	ESP	260
	Smelting Furnaces	ESP	343
	Converters	ESP	232
Phelps Dodge-Ajo	Smelting Furnaces	ESP	310
Copper Range-White Pine	Smelting Furnaces	ESP	190
	Converters	Uncontrolled	340

Table 6-2. ESTIMATED ANNUAL INCIDENCE DUE TO PROCESS EMISSIONS AT SMELTERS WHERE GAS COOLING IS A CONTROL OPTION

Smelter	Process Stream(s)	Annual Incidence (Cases/yr)
Kennecott-Hayden	Smelting Furnaces	0.0028
Kennecott-McGill	Smelting Furnaces and Converters	0.0008
Magma-San Manuel	Smelting Furnaces	0.0013
Phelps Dodge-Ajo	Smelting Furnaces	0.0034
Phelps Dodge-Douglas	Roaster, Smelting Furnaces, and Converters	0.0036
Copper Range-White Pine	Smelting Furnaces	0.0001

Table 6-3. PRELIMINARY ESTIMATES OF COSTS TO APPLY GAS COOLING AS A CONTROL OPTION[a]

Smelter	Process Stream(s)	Annualized Cost
Kennecott-Hayden	Smelting Furnaces	$ 1,200,000/yr
Kennecott-McGill	Smelting Furnaces and Converters	$ 11,800,000/yr[b]
Magma-San Manuel	Smelting Furnaces	$ 4,700,000/yr
Phelps Dodge-Ajo	Smelting Furnaces	$ 1,600,000/yr
Phelps Dodge-Douglas	Roaster, Smelting Furnaces, and Converters	$10,300,000/yr
Copper Range-White Pine	Smelting Furnaces and Converters	$ 2,700,000/yr[c]

[a] Annualized costs include cost of reheating gas stream back to stream temperature before gas was cooled and, except as noted, it is assumed that the existing particulate control device would not have to be replaced.

[b] Includes cost of new particulate control device for the converter stream.

[c] Includes cost of new particulate control device for the smelting furnace stream.

it sublimes, even a substantial lowering of the gas stream temperature may not cause this compound to condense out. As a result, control methods dependent on As_2O_3 condensation would be ineffective.

Furthermore, the commenter stated that most of the As_2O_3 condenses by adsorbing onto the finest particulate matter in the gas stream (under 2 μm). Therefore, arsenic controls must be efficient at collecting the fine particulate fraction. Some particulate control devices (such as ESP's and wet scrubbing systems) are not efficient at collecting fine particles, or the devices fluctuate in their performance levels. As a result of these considerations, the commenter concluded that well-operated and -maintained fabric filters must be required as minimum controls for all arsenic sources (IV-D-698).

Response: Two conflicting points are made by the commenter: (1) that emission control dependent on condensation of arsenic is ineffective and (2) that EPA should require control technologies which are effective in particulate matter control and in particular EPA should require use of fabric filter collectors.

With sources that volatilize arsenic, arsenic emission reductions can be achieved only by cooling the gas stream to condense the arsenic and by collecting the condensed particulate matter. At proposal, EPA used vapor pressure data for As_4O_6 to predict saturation concentrations of arsenic trioxide and hence condensation of arsenic. Since proposal, EPA has conducted additional emission tests at several source categories and reviewed the available data. This investigation has shown that the data do not completely agree with the theory. In particular, the test data for several sources show better collection efficiencies being obtained at high temperatures than were predicted by theory; or more condensation than predicted. This deviation reflects the effects of other factors, such as other forms of arsenic in the gas stream and adsorptive interactions with particulate matter, on the condensation process.

In the case of primary copper smelters where arsenic is present in the form of arsenic trioxide, condensation increases arsenic collection. As discussed in response to the preceding comment, available test data for copper smelters show temperature has a significant effect on the collectability of arsenic, and better arsenic emission control is obtained at lower temperatures. Therefore, EPA concluded that arsenic emissions from primary copper smelters can be effectively controlled by particulate control devices, if the gases are sufficiently cooled.

The EPA agrees with the commenter that for a control device to be effective in reducing arsenic emissions from hot processes, it must be effective in controlling fine particulate matter. Inorganic arsenic emissions from primary copper smelters may be effectively collected through the use of baghouses (fabric filter collectors), ESP's, or venturi scrubbers if emissions are sufficiently precooled. Baghouses and ESP's are used throughout the primary copper industry for control of process emissions from converter operations. The application of venturi scrubbers at copper smelters is limited to a few instances where scrubbers are used as part of the gas precleaning system associated with the sulfuric acid plant. Based on test results, the collection efficiency of baghouses, ESP's, and venturi scrubbers, when applied to process arsenic emission sources, is essentially equivalent in performance, and control efficiencies greater than 97 percent can be achieved. Thus, fine particulate emissions of arsenic can be controlled by well-designed and properly operated baghouse, ESP's, or venturi scrubbers. Consequently, EPA does not believe that baghouses (i.e., fabric filter collectors) should be specified to the exclusion of other control techniques of high efficiency for the particular emission stream (see also Section I-6.5).

I-6.3 DETERMINATION OF EQUIVALENT CONTROL TECHNOLOGIES

Comment: ASARCO objected to the discussion in the proposal preamble (48 FR 33149) concerning the criteria by which equivalency of alternative control measures might be demonstrated. The EPA stated in that discussion that it would be reasonable to consider an alternative capture system equivalent to an air curtain secondary hood system if: (1) the results of a tracer study designed specifically for that system showed an overall average capture efficiency of 95 percent or greater; and (2) no visible emissions were seen to escape the capture system during converter charging.

The commenter felt that this proposal overlooks the fact that the ASARCO-Tacoma prototype air curtain secondary hood, in testing by PEDCo Environmental for EPA (IV-A-4, IV-A-5), achieved somewhat less than 95 percent capture on occasion (and the overall average was in fact 94 percent). The commenter further stated that the standard derivations of the measurements were sufficiently high that capture efficiencies less than 95 percent could reasonably be expected to be found in other tests. In addition, the same test program showed average opacity observations ranging from 21 percent during cold addition charges to 14 percent during matte charges. Since not even the Tacoma prototype hood achieved the levels of performance suggested in the preamble discussion, there is no justification for requiring alternative systems of control to satisfy these criteria in order to be accepted by EPA as equivalent systems. ASARCO further believes that these criteria fail to take into account that air curtain secondary hoods might not be as efficient at other smelters as they were found to be at the Tacoma smelter (see Sections I-2.5.1 and I-2.5.2) (IV-D-620).

Response: Tracer gas injections to test the recovery efficiency of the air curtain system at ASARCO-Tacoma were made on 4 days in January 1983. The average efficiency measured for 45 gas injections on January 14 was 94.0 percent. However, the efficiency for 48 injections performed on January 17, 18, and 19 averaged somewhat higher at 96.0 percent (96.9, 93.9, and 97.3 percent for the 3 days, respectively). As the test report points out (IV-A-4), these results are subject to a ±18 percent error limit, based on uncertainties of ±5 percent in the gas injection rate and ±10 percent in the concentration and gas flow measurements.

Transmissometer readings during the testing showed average opacities ranging from 9 to 21 percent. Observations by qualified observers indicated that the overall capture effectiveness was greater than 90 percent (less than 10 percent of the visible fugitives escaped capture by the air curtain secondary hood).

While these test results are expected to provide guidance to the Administrator in determining whether an alternate system provides equivalent control, the criteria discussed in the proposal preamble were intended only as examples of performance levels that were foreseen at proposal as very likely to qualify an alternate system as equivalent. There is uncertainty in the tracer test efficiencies, and the test results discussed above are representative of the performance of a single air curtain installation. For these reasons, the example criteria were not intended as definite standards of performance for equivalent systems, and would not likely be applied to a given situation as minimum requirements. Equivalency will be judged on a case-by-case basis for exactly the reason pointed out by ASARCO, that plant-specific factors could impact the performance of a smelter's control system, and these factors may have to be considered in evaluating alternate technologies.

I-6.4 WORK PRACTICES

Comment: ASARCO and Phelps Dodge objected to the five work practices in §61.172(a)(2) and §61.182(a)(2) of the proposed standards for high- and low-arsenic smelters, and in particular to §61.172(a)(2)(ii)(C) and §61.182(a)(2)(ii)(C), which state:

> "During skimming, the crane operator shall raise the receiving ladle off the ground and position the ladle as close to the converter as possible to minimize the drop distance between the converter mouth and receiving ladle."

The commenters felt generally that the specification of work practices for copper converting operations is outside the scope of EPA's traditional role, and that they merely repeat the type of practices that the operators would undertake anyway. They further felt that such rules, if adopted, must allow room for operator discretion in their application. The commenters believe that the proposed requirement to hold the ladle off the ground during converter skimming has definite operational, productivity, and safety drawbacks. The cranes have many functions in the smelter operations, and are not necessarily available at the time skimming occurs (a ladle is usually left on the ground next to the converter so that a crane can return for it after skimming). Also, a crane would be subject to an extra heat burden by being forced to wait in the aisle near the converter during skimming. This could lead to extra maintenance and safety problems. A crane in this situation would decrease smelter productivity by not being available to perform its other tasks in the most efficient sequence. The commenters were doubtful that any significant emission reductions would result from the implementation of the proposed work practices. Phelps Dodge felt that the industry should be allowed to establish internal projects to effect optimization of secondary hood performance.

ASARCO and Phelps Dodge also responded to EPA's request for comment in the preamble to the proposed standards (48 FR 33134) on the establishment of minimum time periods for activities called for in some of the work practices. They believe that such time periods would be unwarranted and necessarily arbitrary, and that these operational restrictions would affect productivity adversely, increasing the U.S. copper industry's already severe competitive disadvantage (IV-D-620, IV-D-640, IV-F-1, IV-F-2).

The NRDC voiced support for the proposed operational practices (IV-D-710).

Response: Work practices outlining general operating guidelines for the converter and crane operators at facilities utilizing air curtain secondary hoods were proposed in order to maximize the capture efficiency of this means of arsenic emission control. Observations of visible emissions and the effects of various operating practices were made during the testing performed at the ASARCO-Tacoma smelter in January 1983 (II-A-71, IV-A-4, IV-A-5). The visible emissions observations revealed that fluctuations in converter and crane operation introduce significant variability into the overall hood capture efficiency and that careful operations can minimize fume "spillage" and allow capture efficiencies of 90 percent and greater. Specifically, it was observed that hood capture efficiency increased considerably (to over 90 percent) during converter skimming when the crane operator held the ladle next to the converter while the converter was slowly rolled out to the discharge position. In contrast, when the ladle was placed on the ground during skimming and the skimming rate was rapid, capture efficiencies varied widely from 50 to 95 percent. It was also observed that during matte charging, capture effectiveness was improved if the crane was withdrawn slowly from the space influenced by the action of the secondary hood. During these observations, the crane cables were not observed to affect the secondary load's capture efficiency adversely; however, the crane block did affect capture of emissions when it was placed in the air curtain path. Subsequent to these observations, EPA concluded that certain operational work practices had the potential to markedly increase capture effectiveness, and hence reduce emissions, although the potential emission reduction has not been quantified.

The EPA reviewed the comments on the effects of the proposed ladle-holding requirements on productivity considering the range of typical converter operations at copper smelters. A converter generally completes a cycle in 8 to 24 hours, with slag blowing comprising 70 to 75 percent of the cycle. The remainder of the cycle is spent in charging and skimming operations, and holding due to normal process fluctuations within a smelter. At the end of each slag blowing period, slag is skimmed off the bath and returned to the reverberatory furnace. Typically, the ladle is filled four or five times during each slag skimming which lasts less than 30 minutes. Except for skimming into the first ladle (which may be done when the crane is not in the area), the crane is typically committed to skimming a particular converter and is not available for other activities regardless of the ladle-holding practice used. Thus, it is EPA's conclusion that the requirement that the ladle be held close to the converter during skimming could at worst decrease productivity only slightly. The question of safety hazards was discussed with the USWA industrial hygienist who was familiar with operations at ASARCO-Tacoma. It was the industrial hygienist's impression from discussions with local union members that in the past, some crane operators at Tacoma had routinely held the ladle close to the converter during skimming (IV-E-72). It appears that, despite ASARCO's stated objection to this practice, the company has not found it sufficiently unsafe to forbid it at Tacoma.

The work practice requirements have been generally retained in the promulgated standard. Alternative equipment or operating practices are permitted under the equivalency provisions of Section 112(e) of the Clean Air Act, upon demonstration that equivalent capture efficiency is achieved using these alternate means of control. The Administrator will propose preliminary determinations of equivalent work practices in the Federal Register. At that time, owners and operators can submit information and comment on any adverse effects of, or recommended changes to, methods the Administrator considers necessary to achieve equivalent emission capture.

Minimum time periods for certain work practice activities have not been included in the promulgated regulation. This will allow considerable operator discretion in implementing the work practices in a way that reconciles optimum emission capture with the need to maintain acceptable productivity levels. However, minimum time periods could be included in a future amendment to the regulation, depending on the results of an evaluation of the effectiveness of the work practices and the Administrator's judgment concerning the need to specify time limits.

I-6.5 GENERAL COMMENTS ON BEST EMISSION CONTROLS

Comment: The NRDC agreed with EPA that ASARCO had experienced serious operating problems with the converter building evacuation system at its El Paso smelter, but felt that this control concept should be given further consideration by EPA as an alternative to air curtain secondary hoods (IV-D-710). The State of New Mexico commented that EPA had not examined thoroughly whether a properly designed building evacuation system would in fact capture arsenic more effectively than an air curtain system (IV-D-810). The commenters believed that ASARCO's problems resulted from design flaws in its particular system rather than from any essential shortcomings in the evacuation system concept.

Response: The EPA agrees with the commenter that the concept of building evacuation has merit as a control technique for secondary emissions. Building evacuation was discussed as an alternative for controlling converter secondary emissions in the low-arsenic proposal preamble (48 FR 33141) and BID (Section 3.1.2.7.3). It was stated that EPA believes a well-designed and operated building evacuation system should be capable of achieving at least 95 percent capture of these emissions. This level of control is comparable to that achievable with the air curtain secondary hood technology. However, as pointed out at proposal, the building evacuation systems used currently in the nonferrous metallurgical industry have not demonstrated this level of control.

The ASARCO-El Paso smelter is the only domestic primary copper smelter that uses building evacuation currently to control converter secondary emissions. At the time of proposal, EPA estimated that due to the use of roof ventilators which discharge directly to the atmosphere and increased building openings (to alleviate worker exposure to heat build-up and elevated concentrations of arsenic, lead, and SO_2), the building evacuation system at ASARCO-El Paso was achieving approximately 75 percent capture of secondary emissions. In their comments, ASARCO claimed that since EPA's initial estimate of capture efficiency, roof ventilators in the building have been sealed shut and a new computerized damper system has been installed in the primary hood flue to reduce fugitive emissions (see Section I-4.1.2 of this document). ASARCO estimates the efficiency of the system after these modifications to be about 90 percent. During the review of public comments, EPA contractors visited the El Paso smelter to observe the control achieved by the BE system (IV-B-35). During this visit the improvements to the BE system cited by ASARCO were inspected and visible emissions observations were made both inside and outside the converter building. Based on these observations, it was concluded that 90 percent capture is a reasonable estimate of the capture efficiency presently being achieved by the BE system. However, this is still less than the 94 percent capture efficiency demonstrated to be achievable with an air curtain secondary hood. Furthermore, in their comments, ASARCO stated that the company is also willing to consider installing air curtain secondary hoods at the El Paso smelter, in part to improve workplace conditions and help meet OSHA requirements (IV-D-620).

ASARCO's experience with building evacuation is not presented as evidence that this technique could not achieve a capture efficiency comparable to air curtain secondary hoods. ASARCO's experience does, however, illustrate some of the problems that can be encountered in applying building evacuation to a primary copper smelter.

A building evacuation system would be most effective if integrated into the design of a new smelter. However, potential applications in the copper smelter industry would be retrofits (similar to El Paso), since it is unlikely that new smelters will be built in the foreseeable future. To retrofit an existing facility with a building evacuation system would require that the building be adequately sealed to prevent the escape of fugitive emissions and that sufficient ventilation (to a control device) be provided to assure satisfactory working conditions inside the building. The effectiveness of the system would also depend on how well airflow patterns within the building were controlled.

Assuming an effective retrofit could be accomplished, the associated costs would likely be very high, particularly the capital and annualized costs required for the ventilation air handling system. In general, the technical and cost requirements associated with retrofitting a local ventilation system such as the air curtain secondary hood can be more easily met. In addition, the air curtain secondary hood has been demonstrated to achieve 94 percent capture efficiency. Based on these considerations, EPA chose to analyze the air curtain secondary hood in more depth than building evacuation as a control alternative for converter secondary emissions.

The equivalency provisions of Section 112(e) of the Clean Air Act (see Sections I-6.3 and I-6.4 of this document) allow use of alternative equipment or procedures such as building evacuation to comply with a design, equipment, work practice, or operational standard, provided that will achieve an emission reduction at least equivalent to that achieved under the standard. Where such alternative means of compliance are identified, the Administrator will publish in the Federal Register a notice permitting the use of the alternative means for compliance with the standard. Thus, upon approval, control techniques equivalent or superior to air curtain secondary hoods may be used to demonstrate compliance with the standard.

Comment: The NRDC questioned the Agency's assertion in the low-arsenic proposal preamble (at 48 FR 33142) that baghouses, electrostatic precipitators, and venturi scrubbers are comparable in terms of secondary inorganic arsenic emission reduction performance, achieving control efficiencies "in excess of 97 percent" on secondary offgas streams. However, the commenter pointed out that baghouses have been demonstrated to achieve 99.5 percent or higher. Also, EPA's argument in the same part of this preamble that control efficiencies are generally lower for secondary (low inlet loading) gas streams should be reviewed, and detailed data should be made available to support it (IV-D-710).

Response: The Agency made the point at 48 FR 33142 that baghouses, ESP's, and venturi scrubbers, when applied to process arsenic emission sources, are equivalent in performance. It was further pointed out that, given a sufficiently high inlet arsenic concentration and a sufficiently low offgas temperature, control efficiencies over 97 percent percent can be achieved. These conclusions relating to controls on process gas streams were based on examination of test results from these three types of control devices as presented in Section 3 of the proposal BID's. For example, the baghouse controlling arsenic emissions from the multi-hearth roasters at ASARCO-Tacoma collected arsenic at 99.7 percent, and Anaconda's process baghouse achieved an average efficiency of 98.9 percent. The cold ESP at ASARCO-El Paso achieved an average control efficiency for arsenic of 97.8 percent. Finally, the venturi scrubber used to clean the roaster offgases at Kennecott-Hayden exhibited an average efficiency of 98.4 percent. All of these average control efficiencies are very good, are quite close to one another, and can be considered for the purposes of a general discussion to be equivalent. Of course, more detailed characterization of the capabilities of these three control technologies would have to consider system operating parameters, gas stream temperatures and grain loadings, particle size distributions, and other factors that can affect measured efficiencies of particular installations. It should be noted that the baghouse controlling the arsenic plant at ASARCO-Tacoma was also tested in September 1978 (Table 3-6 of low-arsenic BID I) and showed efficiencies of 95.9, 97.7, and 94.5 percent for arsenic in three sample runs. Tests conducted in September 1983 on the replacement baghouse for the arsenic plant showed arsenic collection efficiencies of 99.4, 99.4, and 99.6 percent (see Appendix H, Section H.3). The Agency believes that, while baghouse controls can be superior in many applications (such as when the gas stream temperature and moisture content are within tolerable limits), they should not be specified to the exclusion of other control techniques of high efficiency.

The statement in the preamble that these three control technologies are comparable in terms of secondary arsenic control performance was an opinion based on the observation of these controls in many industry applications that parallel the control of secondary emissions at primary copper smelters. While venturi scrubbers are capable of high control efficiencies for fine particulate matter, the disadvantages of high operating costs and water handling problems were cited in the preamble to highlight their generally lower desirability for applications where baghouses or ESP's could be used. The statement that control efficiencies are often lower for low concentration inlet gas streams is also based on observations of the performance of control devices in many industry applications. In the case of primary copper smelters, this behavior is seen when the baghouse test results at three smelters are examined. The baghouses controlling process offgases at ASARCO-Tacoma and Anaconda saw average inlet arsenic loadings of 288 and 885 mg/dscm, (0.126 and 0.387 gr/dscf), respectively, compared to only 3.27 mg/dscm (0.001 gr/dscf) in a test of ASARCO-El Paso's converter building evacuation system's baghouse. The average control efficiency at El Paso was measured as 96.2 percent, considerably lower than the 99.7 and 98.9 percent percent efficiencies seen at Tacoma and Anaconda on process gas streams. These comparisons reinforce previous observations that indicate a generally lower control efficiency of many control devices for inlet streams with lower grain loadings.

Comment: The State of New Mexico stated that EPA had failed to address the question of appropriate BAT controls for new copper smelters, instead stating merely that no new smelters were projected to be built in the first 5 years of the standards. This commenter felt that a thorough "BAT review" for new primary copper smelters would result in additional controls beyond those proposed for existing smelters (IV-D-810).

Response: The response in Section I-2.3 explains EPA's reasons for believing that no new smelters are likely to be built within the next 5 years. It was for these reasons that EPA concluded that it would not be a productive use of Agency resources to define control measures for new smelters that may never come into existence. Should any new primary copper smelters be constructed and the converter arsenic feed rate is above 75 kg/h (164 lb/h), the standard would require control of converter secondary emissions. Furthermore, any new smelter would have to comply with the requirements of the new source performance standard for primary copper smelters (40 CFR 60, Subpart P) which limits process emissions from dryers, roasters, smelting furnaces, and converters.

The need for and the applicability of additional controls depends to a large degree on knowledge of specific processes and feed materials. Thus, EPA believes that additional control measures for new sources should be evaluated only when accurate projections of new construction can be made. Since the standard for inorganic arsenic emissions will be subject to periodic review, EPA believes that a sufficient mechanism exists for applying appropriate controls to new facilities in the primary copper smelter source category if this should become necessary.

I-6.6 ADDITIONAL CONTROL OPPORTUNITIES

Comment: Sierra Club, Grand Canyon Chapter, commented that too few control alternatives were considered in the proposal, and stated that the enclosed hood-baghouse system (such as used at Kennecott-Hurley) and by-product systems should be considered for application to each of the smelters (IV-D-608).

United Steelworkers of America felt that additional controls, at the level of best available technology, should be required on all sources of inorganic arsenic (IV-D-708). The State of New York objected to EPA's proposal to allow many smelters to continue using their existing controls, instead of requiring the very best technology available, as required under Section 112. This commenter felt that a new proposal should be issued with more comprehensive controls on all arsenic emission sources (IV-D-698).

Response: It is EPA's belief that significant sources of inorganic arsenic emissions at primary copper smelters were indeed considered for regulation during development of the proposal. In deciding which emission sources should be regulated, the Agency considered several factors. Central to this process was the consideration that it might become necessary to tolerate a certain degree of residual health risk to exposed populations in cases where stringent controls would lead to unduly harsh economic conditions for a copper company, or where the ongoing costs to operate and maintain controls would be disproportionately high in relation to the amount of risk reduction achieved. While some commenters felt that the costs of controlling inorganic arsenic should not be considered in the development of the regulation, the Administrator has made the judgment that consideration of costs is necessary.

In all of the cases of arsenic emission sources where no new controls or additional controls were proposed, the Agency had analyzed the availability of additional controls, the degree of emission reduction and the reduction in health risk expected if those controls were applied, as well as the cost to implement the controls, and determined that further controls would not be reasonable. For example, additional controls were considered for process sources (roasters, furnaces, and converters) at all of the smelters. For all cases except the converter primary offgases at Kennecott-McGill, it was predicted that additional process controls would not enhance the inorganic arsenic collection already being achieved at the smelters. While additional control could be realized at Kennecott-McGill, EPA's economic analysis indicated that this smelter would be likely to close if required to install process controls. Unfortunately, the financial condition of domestic copper smelters is currently quite weak due to the condition of the world copper market. This fact is highlighted by recent closures of ASARCO's Tacoma smelter, Kennecott's Utah smelter, and Phelps Dodge's Ajo smelter. The EPA believes it is appropriate to consider this overall industry situation as reflected in the status of individual smelters when developing this NESHAP. This situation will be reassessed in future reviews of the standard. The Agency feels that the required "ample margin of safety" of public health (the determination of which is left in the Act to the Administrator's judgment) has been provided through this approach.

In a manner similar to process controls, the feasibility of secondary emission controls was examined for each smelter. At eight of the smelters, EPA concluded that the cost of converter secondary controls would be disproportionately high relative to the small arsenic emission reductions achieved by the controls. The other six smelters processing low-arsenic concentrates were covered in the proposed regulation.

For matte and slag tapping controls, regulation of four smelters was considered reasonable in light of the emission reductions achieved and the costs of the controls. (Based on available information on smelter arsenic balances, the final regulation is expected to affect only one smelter. The regulation also does not require application of matte and slag tapping controls since they would achieve only negligible risk reductions and would impose costs that are greatly disproportionate to the risk reduction achieved. These changes from the proposed requirements were made on the basis of information received and analyses performed after proposal, and are discussed further in Sections I-1.1, I-4, and I-8 of this document, and in the preamble to the promulgated standard.)

The residual health risk remaining after the best emission controls were applied was examined and the Agency determined that in several cases additional controls would not cause a significant reduction in emissions, and in the remaining cases the smelters would likely face closure.

Other sources of potential inorganic arsenic emissions include miscellaneous fugitive sources primarily related to dust handling and housekeeping practices. Many of these sources are associated with the air pollution control system, and requirements for proper operation and mainatenance of this system are separately established in Subpart A of 40 CFR 61. For this reason, explicit requirements relating to dust handling and maintenance practices were not included in the proposed standard for primary copper smelters. The Agency would like to emphasize that the final standard (and 40 CFR 61, Subpart A) does require proper operation and maintenance of all control devices, proper disposal and handling of collected particulate matter, and proper maintenance of duct work conveying emissions to the control device. Other miscellaneous fugitive emission sources typically account for only a small proportion of total emissions. Thus, control requirements for these sources were not established.

I-7.0 COMMENTS ON PROPOSED EMISSION LIMIT

I-7.1 EMISSION LIMIT TOO STRINGENT

Comment: ASARCO and Phelps Dodge felt that the proposed emission limit of 11.6 mg/dscm (0.005 gr/dscf) of particulate matter on captured converter and smelting furnace tapping secondary emissions is overly stringent and has not been shown by EPA to be achievable on a continuous basis. The proposed emission limit is based on three sample runs on the converter building baghouse at the ASARCO-El Paso smelter.

ASARCO stated that the proposed emission limit was based on manifestly inadequate data, since the majority of available data reflects a failure of baghouses in similar control situations to achieve the limit. Furthermore, the company argued that three sample runs are too few to have statistical significance in setting a standard. ASARCO supplied results of particulate emission tests performed on several baghouses by the company and others which showed that the limit was rarely achieved. ASARCO also felt that the lower inlet grain loadings associated with secondary streams would not allow the limit to be achieved any more easily, since there is no direct relationship between inlet and outlet loading levels. This commenter was concerned that the existing control devices at the ASARCO-Hayden and other smelters would not be able to meet this standard, and felt that EPA should establish an emission limit that existing devices could meet. The company recommended that the NSPS limit for particulate matter of 50 mg/m^3 (0.022 gr/scf) be adopted instead.

Phelps Dodge also felt that there is no sound basis for the standard, stating that EPA had ignored results from several emission tests in selecting the limit. The company cited EPA test results presented in Appendix C of BID, Volume I, showing average particulate emissions of 46.7 mg/dscm (0.020 gr/dscf) from the Anaconda baghouse and 16.5 mg/dscm (0.007 gr/dscf) from the Phelps Dodge-Douglas baghouse. They also referred to 21 more emission tests the company had performed between 1977 and 1980 at the Douglas smelter that showed average particulate emissions of 32.7 mg/dscm (over half the tests with results over 11.6 mg/dscm). The company felt the proposed emission limit is overly strict in light of the majority of the test data and the fact that the NSPS limit is 50 mg/dscm (IV-D-620, IV-D-640, IV-F-1, IV-F-2).

Response: The EPA does not agree with the commenters that the proposed emission limit is overly stringent so as to be unachievable on a continuous basis. In order to select this limit, the Agency reviewed particulate matter source test results for control devices judged to represent the best technology for controlling converter secondary emissions. The available source test data for such control devices consisted of one series of three test runs conducted in 1978 on the baghouse treating emissions captured in the ASARCO-El Paso converter building evacuation system. Emissions of particulate matter in these runs were 1.1, 2.5, and 11.6 mg/dscm (0.0005, 0.0011, and 0.0051 gr/dscf, respectively). These were the only data available that reflected the operation of the best control technology on a converter secondary emission stream.

The level at which an emission standard should be set, given a particular body of test data, is a matter of judgment. Some argue that the best observed control level should be selected as a standard to be imposed on all control systems, while others argue for the lowest control level or some intermediate level. The EPA selects an emission limit based on the amount and quality of available data, and on the Agency's judgment concerning the capabilities of similar control technologies across a range of similar applications. In this case, the test run indicating the highest emissions was selected to allow a reasonable margin for differences among facilities and control devices, and for variations in sampling procedures and analytical methods.

The test data submitted by ASARCO were reviewed by EPA for comparison to the data considered in selecting the proposed emission limit of 11.6 mg/dscm. For the 17 tests showing a figure for inlet grain loading, the inlet particulate concentration ranged from 0.3 to 65 g/dscm (0.133 to 28.40 gr/scf), averaging about 8 g/dscm (3.5 gr/scf). In contrast, inlet concentrations in the testing used in selecting the standard never exceeded 71 mg/dscm (0.031 gr/dscf). Inlet concentrations were not shown for the remaining 57 tests or test runs in the data submitted by ASARCO, and so the gas stream conditions in these tests cannot be evaluated for their similarity to EPA's reference data base from ASARCO-El Paso. Since the inlet conditions in these tests were considerably different from those expected in a gas stream containing converter secondary emissions, the performance of these control devices is not considered indicative of the expected performance of well-operated devices controlling converter secondary emissions. One test consisting of two runs on the ASARCO-El Paso converter building baghouse performed in 1983 showed outlet concentrations of 85 and 167 mg/dscm (0.037 and 0.073 gr/scf, respectively). However, EPA found in its review of the test report that the condition of the control device was not reported. In addition, these outlet concentrations exceed the inlet concentrations measured at the same baghouse in the 1978 test program. These factors suggest that the condition of this baghouse in 1983 may have deteriorated from the level in 1978, and therefore did not reflect the performance of the best control systems necessary under this NESHAP.

Tests were run in 1977 on the spray chamber/baghouse system at the Anaconda smelter. (The smelter has since been permanently closed.) This control system collected process gases from roasting, smelting, and converting operations, and inlet particulate concentrations to the system were found to average about 14 g/dscm. Because of these high inlet concentrations, which are orders of magnitude higher than those in a converter secondary capture system, the results from this testing could not be considered in selecting an emission limit for a secondary hood system. The baghouse at the Phelps Dodge-Douglas smelter collects captured fugitive emissions from the calcine discharge operation, and inlet particulate concentrations averaged about 5,800 mg/dscm in the EPA testing referred to by Phelps Dodge. As in the case of the Anaconda testing, the inlet conditions to the baghouse are not representative of the inlet conditions experienced in a converter secondary control system. The conclusion concerning the test results submitted by ASARCO is therefore also applicable to the results cited by Phelps Dodge, that EPA does not consider the performance of these control devices indicative of the operation of the best control systems applied to converter secondary emission streams.

In arguing that lower inlet grain loadings than reflected in its submitted baghouse data would not necessarily lead to lower outlet loadings, ASARCO presented emission data for the arsenic plant baghouse at its Tacoma smelter indicating that higher outlet loadings tended to be associated with lower inlet loadings. The EPA reviewed the data cited by ASARCO and found the data included one inlet test that was reported to be biased low owing to loss of part of the sample during analysis. When this test is excluded from the data set, the remaining 3 inlet concentrations only vary by 20 percent and the collection efficiencies varied from 99.95 to 99.97 percent (IV-A-6). Thus, the data do not support ASARCO's argument. The Administrator agrees that lower inlet concentrations will not guarantee that the proposed emission limit will be achieved, and the limit was not selected on this basis. The EPA believes that the emission test data upon which a standard is based should insofar as possible reflect the operating conditions and gas stream characteristics that will exist at the sources expected to be regulated. In attempting to confirm the achievability of the selected limit through an examination of best technology applied to similar sources, the Agency examined the available test data for electric arc furnaces (EAF's) used in the steel industry, whose particulate emission streams have similar size distributions and concentrations to those of converter secondary emissions. Emission test data for well-controlled EAF's show that emission rates below 11.6 mg/dscm are consistently achieved (EPA-450/3-82-002a), and EPA has established an NSPS emission limit for this source of 12 mg/dscm (0.0052 gr/dscf). A more detailed discussion of the supporting data for the selected limit is contained in Appendix E.

The Administrator considered the arguments and data submitted by these two commenters, and concluded that selecting the NSPS emission limit of 50 mg/dscm (0.022 gr/dscf) for this NESHAP would not be appropriate. (The NSPS limit applies to particulate emissions from ore concentrate heaters.) Emission test data for ASARCO-El Paso and other smelters show that uncontrolled converter secondary emission gas streams often contain less than 50 mg/dscm of particulate matter (average for three runs in the 1978 testing at El Paso was 50 mg/dscm). Thus, an emission limit of 50 mg/dscm would mean that little or no control would be required on converter secondary emission streams. The Administrator decided after evaluating the data and arguments submitted by these commenters that the proposed emission limit should not be made less stringent as suggested.

I-7.2 EMISSION LIMIT TOO WEAK

Comment: The NRDC and the State of New Mexico stated their belief that the selected emission limit is too weak because it is based on the worst results of three tests on the ASARCO-El Paso converter building baghouse. The particulate matter emissions from the control device outlet ranged from 1.1 to 11.6 mg/dscm, the average for the three runs being 5.1 mg/dscm. The NRDC enumerated several factors arguing for a reconsideration of the limit to reflect the level that can be achieved by properly operated state-of-the-art controls. First, the inlet concentrations entering a baghouse from a converter air curtain capture system would be higher than those from the El Paso building evacuation system (and for this reason a baghouse on an air curtain system may show better performance). Also, EPA concedes (page 3-81 of the proposal BID) that the tested baghouse is capable of achieving much higher removal efficiencies (as high as 99 percent) than reflected by the proposed emission limit. Finally, EPA must set the standard at a level that represents what can be achieved by the best technology in use; i.e., the best (or at least the average) of the three tests should be the reference for setting the standard (IV-D-710, IV-D-810).

Response: As described in the previous response, EPA took the approach of selecting an emission limit that reflects not the lowest level observed in the available test data, but a limit that allows a margin for process fluctuations and for small variations in sampling and analytical procedures. Since the data base for this limit represents testing of a single control device, this consideration assumes more importance than it would if there were more test data available.

In selecting a regulatory emission limit, the Agency must make a judgment concerning the level of emission reduction that control devices can meet continuously at the variety of facilities and under the different operating conditions to be found throughout a particular industry. It should be kept in mind that the performance of any control device will fluctuate as inlet gas stream characteristics and its own condition (e.g., wear on filter bags) change over time. The apparent control efficiency can also be affected by small variations in sampling techniques and analytical methodology. This means that a properly operated and maintained control device will frequently achieve emission reductions in excess of the regulatory limit as a result of these fluctuations. However, the emission limit is selected so that fluctuations in the direction of increasing emissions will seldom if ever cause the limit to be exceeded. As a result, a state-of-the-art control device operated properly would be expected to operate much of the time at a somewhat better level than the level required in the regulation.

The EPA believes that the selected emission limit is stringent enough so that the best control devices, properly operated and maintained, are needed to achieve the limit on a continuous basis. As a result, the proposed limit of 11.6 mg/dscm (0.005 gr/dscf) is retained in the promulgated standard. The regulation will be reviewed periodically and test results at regulated sources will be evaluated to determine whether any revision to the emission limit is appropriate.

I-8.0 COST ESTIMATES AND ECONOMIC IMPACTS

The EPA received several comments on the control costs estimated by the Agency at proposal, and on the economic analysis of the affordability of arsenic controls for low-arsenic primary copper smelters. The EPA's analysis of the costs and economic impacts of controls on the copper smelting industry and on individual primary copper smelters was contained in Sections 6 and 7 of the background information document for the proposed standard, BID, Volume I. ASARCO, Kennecott, and Phelps Dodge felt that estimated costs for six of their smelters were underestimated in the proposal, and they supplied their own estimates of what the costs of the best emission controls would be under the NESHAP standard.

Commenters on EPA's assessment of the economic impacts of controls generally felt that the depth of information used in the analysis was lacking, or that economics should not play a role in regulatory decisions regarding hazardous air pollutants. The Agency has retained its examination of economic impacts in promulgating the final standard; however, a revised analysis has been carried out and is presented in Appendix F of this document.

Several factors contributed to the higher cost estimates of the commenters. Whereas EPA had assumed that the ducting and fans in existing secondary control systems were salvageable for use in a new air curtain system, most smelters included a significant added capital cost for new fans and ductwork (plus a cost for demolition of existing hoods and ductwork). Also, several site-specific factors arising from differences between these smelters and the ASARCO-Tacoma configuration used by EPA as a basis for costing caused some cost components to be estimated higher by the commenters. In estimating a figure for capital recovery, the three copper companies assumed an interest rate on borrowed capital of 15 percent and an equipment service life of 15 years (0.1710 capital recovery factor). EPA's assumption at proposal was a 10 percent interest rate and a 20-year service life (0.1175 capital recovery factor). Since the Agency's calculation methods assume dollars of constant value in considering annualized costs, when in fact the economy was at the time of proposal experiencing an inflation rate of about 5 or 6 percent, the assumed real, pre-tax interest rate of 10 percent was selected to compensate for this and express annualized costs in terms of the number of current dollars to be paid out in future annualized expenditures. Thus, the nominal equivalent percentage rate is very close to the 15 percent suggested by the companies. In the cost analysis, an equipment service life of 20 years was used because that is the service life generally assumed for sheet metal and it was used by ASARCO to amortize the cost of installation of launder covers at Tacoma.

Another factor in favor of the 10 percent interest rate is the availability of tax-exempt municipal revenue bond issues. In general, interest on these issues is well below 10 percent. Examples are cited below:

- ASARCO - $80,000,000 at a weighted average interest of 7.2 percent in 1982 and 10.8 percent in 1981,

- Phelps Dodge - $97,700,000 at 5.60-6.25 percent for the Douglas smelter and $118,000,000 at 7 percent for the Morenci smelter,

- Magma - Air pollution revenue bonds at 3.675 percent plus or minus 50 percent of the difference between the prime rate and 5 percent,

- Kennecott - $122,000,000 at 6.5-7.5 percent and $55,700,000 at a variable tax-exempt rate.

Changing the interest rate from 10 to 15 percent and the equipment life from 20 to 15 years would increase the annualized cost by 18 to 27 percent. Cost effectiveness and maximum price effects are affected in a comparable manner. However, these changes do not affect the ranking of the hazards or the regulatory decisions.

In its evaluation of whether the capital cost estimates submitted by commenters were reasonable, EPA concluded that the smelter owners and operators are in the best position to consider the effect on costs of site-specific factors at each smelter. The Agency felt that generally if the companies' cost estimates were based on sound design, engineering, and cost estimating principles, those estimates would be accepted as reasonable for the purposes of the updated cost analysis. The EPA's revised cost estimates were used in the same way as the estimates at proposal, to evaluate the affordability of controls and the cost to a smelter per unit of arsenic emission reduction achieved by the controls.

I-8.1 COST ESTIMATES FOR PROPOSED CONTROLS

I-8.1.1 ASARCO, Incorporated Smelters

I-8.1.1.1 Hayden Smelter

Comment: ASARCO claimed that EPA had greatly underestimated the capital and annualized costs to install and operate converter fugitive emission controls at its Hayden smelter. The EPA's capital cost estimate for these controls was based on ASARCO estimates (page 6-14 of BID, Volume I) of capital costs to install air curtain secondary hoods at ASARCO-Tacoma ($322,200 per converter). However, because of individual plant configuration differences, this estimate can serve only as an approximation when applied to other smelters. For example, the converter aisle at the Hayden smelter is approximately 4 meters (13 feet) narrower than the aisle at Tacoma, necessitating the installation of more expensive cantilevered hoods above the five Hayden converters. The company felt EPA's capital cost estimate of $1.7 million was too low because of such site-specific differences, and because several direct and indirect costs were not included in the estimate. A major cost item not considered was the cost for demolition of the existing converter secondary hoods. ASARCO supplied a capital cost itemization for the installation of five cantilevered air curtain secondary hoods, totaling $3.66 million.

ASARCO also estimated the capital cost of installing air curtain secondary hoods similar to those at ASARCO-Tacoma, saying that this estimate indicates how costs could escalate if Tacoma-type hoods were required for the Hayden smelter. ASARCO claimed that, in order for this installation to be performed, expensive structural conversion work (over $8 million additional capital cost) would be necessary to provide clearance for the hoods in the converter aisle. This conversion would include raising the converter aisle crane rail at least 1.5 m (5 feet). Another cost to ASARCO would include $6 million for being shut down for 1 month during the installation, making the total capital cost for this alternate control installation approximately $18 million.

ASARCO further claimed that EPA's annualized cost estimate was too low ($408,400 per year versus ASARCO's estimate of $1.35 million per year for the cantilevered hood installation) because of EPA's assumption concerning the cost of capital (10 percent interest rate instead of 15 percent), the annualized cost resulting from the $1 million writeoff for existing control equipment that was not considered ($171,000 per year), and EPA's failure to include a pro rata share of the cost to operate the existing ESP ($185,800 per year), into which the captured secondary emissions would be ducted. The company claimed that the inclusion of the shared cost of existing controls was necessary to give ASARCO credit for being the first to install controls and that EPA's approach would give industry an incentive to delay installing controls. In addition, EPA's approach would penalize ASARCO by not providing a cost credit for the existing secondary hoods which would have to be scrapped if air curtain type hoods were required (IV-D-620, IV-F-1, IV-F-2). ASARCO reiterated its concerns about EPA's cost assumptions in the comments it made on EPA's response memorandum (IV-D-811).

Response: The capital cost itemization provided in Attachment D of ASARCO's December 9, 1983, comment submittal (IV-D-620) indicated by general cost category the derivation of the company's total capital cost estimate of $3.66 million. In order to evaluate this capital cost estimate more completely, EPA sought further cost details after proposal in a request for information sent to ASARCO (IV-C-418). ASARCO responded to this request with a more detailed capital cost breakdown that allowed EPA to evaluate the reasonableness of ASARCO's higher estimate (IV-D-789). The capital cost claimed by ASARCO in its comments was composed essentially of the same cost elements assumed in EPA's estimate at proposal (as derived from ASARCO's estimates for the Tacoma installation). The major part of the difference between EPA's proposal estimate of $1.7 million and ASARCO's claim of $3.66 million consisted of direct cost items pertaining to the demolition of the existing secondary hoods, and to the actual costs of the new air curtain secondary hood and ductwork structures. In the Agency's development of a capital cost estimate, no cost was attributed to the demolition of the existing hoods. In addition, no cost for new ducting was assumed because EPA believed that all existing ducting could be used in the air curtain installation. However, ASARCO stated that the existing secondary hoods and ducting would not be suitable for use in the air curtain capture system. The EPA evaluated the claimed costs specific to this site and determined them to be reasonable for the work proposed to be necessary for the installation at ASARCO-Hayden. Finally, the specially designed cantilevered hoods considered necessary by ASARCO due to space limitations in the converter aisle at the Hayden smelter would be considerably more expensive than the hoods that were costed for installation at Tacoma. These higher direct (hardware) costs also would be reflected in generally higher indirect costs (e.g., engineering, contingencies), since indirect costs are typically estimated as a proportion of direct costs.

In summary, ASARCO's higher capital cost estimate is due primarily to certain site-specific factors that were not considered in EPA's cost analysis at proposal. The EPA has evaluated ASARCO's cost itemization and found these costs to be reasonable, considering the requirements of this installation. The alternate control option of raising the crane rail and installing Tacoma-type hoods at a cost of $18 million is considerably less desirable than the installation of cantilevered hoods at a cost of $3.66 million, based just on a comparison of the costs of the two options. As a result of these considerations, the company's capital cost estimate of $3.66 million has been accepted in EPA's reanalysis of the costs of best emission controls for converter operations at ASARCO-Hayden.

ASARCO's comment submittal provided a breakdown of total annualized costs for the five air curtain secondary hoods proposed for the Hayden smelter as follows: $626,000 capital recovery (on $3.66 million), $185,000 operating cost, and $183,000 maintenance cost (5 percent of total capital cost), for a total annualized cost of $994,000 for the first year. The capital recovery factor of 0.1710 used by ASARCO was based on a 15 percent interest rate on borrowed capital and a 15-year equipment life. As stated earlier, EPA used a capital recovery factor which is based on 10 percent interest and 20-year equipment life because EPA believes this represents a reasonable estimate of costs that would be incurred with installation of converter secondary emission controls. ASARCO's capital recovery estimate was adjusted to EPA's basis, yielding a revised capital recovery cost of $430,000 per year. Since ASARCO's estimates for operating and maintenance costs are considered reasonable, they were accepted and added to the capital recovery estimate, to produce a total annualized cost of $798,000 per year.

The EPA has reviewed ASARCO's claim, offered in both sets of comments on EPA's cost analysis for ASARCO-Hayden, that the annualized costs accruing from writing off the value of the scrapped existing secondary hoods and from sharing the cost of operating the existing R&R cottrell (to which converter secondary emissions captured by the air curtain hoods would be ducted) should be included as part of the NESHAP cost in EPA's cost analysis. In EPA's response memorandum, these claimed cost penalties to ASARCO were disallowed for several reasons. In both of these instances, ASARCO is requesting that costs associated with existing equipment be considered in estimating the cost of new controls. The EPA responded in the memorandum that it is not the Agency's policy to include the cost for book writeoff of existing controls in estimates of the annualized costs of new controls over baseline costs. (Such a writeoff would not represent an out-of-pocket expenditure, and would generate a tax credit for the company.) The operating costs of the ESP presently in place are part of the smelter's current budget, and EPA stated in its response that these costs should not change significantly if additional captured emissions were ducted to the device. For these reasons, these annualized cost components claimed by ASARCO were not included in EPA's revised cost estimate for ASARCO-Hayden, and the figure of $798,000 per year was used in the updated cost analysis after proposal.

In its comments on EPA's response memorandum, ASARCO maintained that, while the book writeoff may not represent a current expenditure and would lead to a tax credit, the company would still be denied full use of past expenditures and there would still be a significant after-tax cost to the company. ASARCO also stated that a portion of the existing ESP could theoretically be partitioned off and made inoperative if the new standard was not applicable to the Hayden smelter. Following review of ASARCO's arguments, EPA has concluded that changing its decision to disallow inclusion of the two cost components is not appropriate, for the following reasons. Most smelters have various forms of capture and collection equipment currently installed, and would have to replace certain segments of the existing control installation if improved control were required. In addition, the reduced emissions due to existing control equipment are considered (i.e., credit is given) in establishing the baseline emission level for a smelter. Thus, the potential emission (and risk) reduction at a currently controlled facility is smaller than at an uncontrolled facility and, therefore, the likelihood of the controlled facility being further controlled is lower. While the ESP could theoretically be partitioned off, this step has not been taken under the present control situation, and so the potential cost savings in the absence of the NESHAP is not being realized. Furthermore, the potential cost savings can only be determined from a detailed engineering analysis. To conduct such an analysis would result in further delays in issuance of this standard.

In summary, EPA has maintained its revised annualized cost estimate of $798,000 per year, as presented in the response memorandum. This figure is about twice the estimate of $408,400 per year made by EPA at proposal. Since EPA has determined that air curtain secondary hoods installed on the converters at ASARCO-Hayden would not bring about a significant reduction of health risk to exposed populations, increasing the annualized cost estimate would have no effect on the applicability of this regulation to the ASARCO-Hayden smelter.

I-8.1.1.2 El Paso Smelter

Comment: ASARCO claimed that EPA's capital and annualized control cost estimates for its El Paso smelter were understated. ASARCO estimated the capital cost of installing air curtain secondary hoods at $1.85 million, or 35 percent higher than EPA's estimate of $1.38 million. Annualized costs were claimed to amount to $727,000 per year, or about 2.3 times EPA's estimate of $307,000 per year. In its comments after proposal, the company supplied a breakdown of the capital cost elements for this project, stating that, unlike the situation at its Hayden smelter, air curtain hoods similar to those at ASARCO-Tacoma could be installed at the El Paso smelter without extensive modifications. In commenting on EPA's revised control cost estimates, however, ASARCO provided a higher capital cost estimate of $3.5 million. The company said it had reconsidered its original design, and had modified the fan configuration and specified a heavier hood design. They added that operating and maintenance cost estimates would increase proportionately over the company's original post-proposal estimates. ASARCO's higher annualized cost estimate derives from assumptions similar to those used by ASARCO for the ASARCO-Hayden estimates, including a pro rata share for operating the converter building baghouse ($247,500 per year) (IV-D-620, IV-D-811, IV-F-1, IV-F-2).

Response: ASARCO provided a capital cost breakdown in Attachment D of its December 9, 1983, comment submittal (IV-D-620), which indicated the distribution of its estimated costs among several direct and indirect cost categories. In its response to EPA's request for information after proposal (IV-C-418), the company provided a more detailed breakdown of estimated capital cost by specific expenditure (IV-D-789). ASARCO's estimate of $1.85 million provided after proposal is based on factors similar to those incorporated in EPA's capital cost figure. Certain smelter-specific factors, including demolition and ductwork costs, are higher in the company's estimate. The EPA's estimate included the relatively low figure of $350,000 for additional ductwork, due to the assumption that existing (building evacuation system) ductwork was salvageable for use in the new air curtain secondary hood system. Also, ASARCO made its original cost estimate for this installation in March 1981, and then escalated the estimate after proposal to reflect a current dollar value (approximately August 1983) by applying a factor of 1.19 (using the Engineering News Record index). The EPA's estimate was based on January 1982 cost estimates for an installation at ASARCO-Tacoma, updated to December 1982 dollars. With regard to ASARCO's higher capital cost estimate contained in the company's later comment submittal, EPA in the interest of completing the regulatory development in a timely fashion could not request from the company further details about ASARCO's modified control system design. These details would have been necessary in order for EPA to complete an analysis of the reasonableness of ASARCO's estimates. As a result, the company's original estimate of $1.85 million has been used in EPA's reanalysis of converter control costs at the El Paso smelter. To determine the appropriateness of the decision not to seek additional details about ASARCO's modified capital cost figure, EPA examined the impact that the higher capital cost figure would have on the regulatory decisions affecting ASARCO-El Paso. The Agency has concluded that using the higher capital (and resulting annualized) costs would have no impact on the regulatory action.

ASARCO's comment submittal provided a breakdown of total annualized costs for the El Paso smelter's three converter air curtain secondary hoods, similar to the breakdown provided for annualized costs at the company's Hayden smelter. The breakdown for ASARCO-El Paso included: $318,000 capital recovery (on $1.85 million), $105,000 operating cost, and $56,000 maintenance cost (3 percent of total capital cost), for a total annualized cost of $479,000 for the first year. As with the costs for the Hayden smelter, EPA adjusted the capital recovery portion of the total annualized cost for El Paso (from 15 percent interest rate and 15-year equipment life) to a standard basis representing a 10 percent interest rate and 20-year equipment life. This yielded a figure for capital recovery of $218,000 per year. Again, as in the case of the Hayden smelter, the operating and maintenance costs suggested by ASARCO were considered reasonable, and were added to the adjusted capital recovery figure to produce an updated estimate of total annualized cost of $379,000 per year (23 percent higher than EPA's proposal estimate). Almost 80 percent of this increase over the proposal estimate is due to the higher capital recovery figure occasioned by the 34 percent higher capital cost estimate.

The EPA's response to ASARCO's claim that a pro rata share of the existing converter building baghouse's operation should be assigned to the costs incurred due to NESHAP controls is the same as for the case of the Hayden smelter. Since the total cost of operating this baghouse is a part of ASARCO's current budget (no sections partitioned off), and would not change significantly as a result of NESHAP controls, no incremental costs of operation should be assigned to the standard. Therefore, the total annualized cost of controls cited above, $379,000 per year, is used in EPA's updated analysis of converter control costs for the ASARCO-El Paso smelter.

I-8.1.2 Kennecott Smelters

I-8.1.2.1 Utah Smelter

Comment: Kennecott commented that EPA's estimates at proposal of the costs of installing and operating best fugitive arsenic emission controls on converter and matte and slag tapping operations at Kennecott-Utah were understated. The company felt the major reason for EPA's low estimate of the costs of converter controls was that the costs of similar controls at ASARCO-Tacoma were used as a basis, despite the "striking difference" in size between the two smelters and the fact that the Utah smelter has existing secondary controls on converters. Kennecott supplied its estimate of total capital, operating, and annualized costs for converter and matte and slag tapping controls. Total capital cost was estimated at $18.5 million, versus EPA's proposal estimate of $7.0 million. The total annualized cost was estimated to be $5.8 million per year, in contrast to EPA's estimate of $1.8 million per year (IV-D-634).

Response: The capital and annualized cost estimates submitted by Kennecott in its comments reflected the total costs of best emission controls on fugitive emissions from both converters and matte and slag tapping (smelting furnace) operations. In order to examine Kennecott's cost breakdown for each of these control categories independently for comparison to EPA's separate cost estimates, EPA requested more detailed cost information after proposal in a request sent to Kennecott (IV-C-416). Kennecott responded with a detailed breakdown that allowed EPA to assess the reasonableness of the company's estimates (IV-D-788). Table 8-1 summarizes EPA's proposal estimates and Kennecott's post-proposal estimates of the costs of the best controls on converter and matte and slag tapping operations.

Table 8-1. FUGITIVE EMISSION CONTROL COSTS FOR KENNECOTT-UTAH

Cost Category	EPA Proposal Estimate		Kennecott Estimate	
	Converters	Matte, Slag Tapping	Converters	Matte, Slag Tapping
Capital ($ million)	5.2	1.8	8.8	9.6
Annualized ($ million/yr)	1.3	0.5	2.8	2.9

The EPA's estimate of the capital cost of NESHAP converter controls was based on the assumption that no new ducting or fans would be required for the BAT control installation at the Utah smelter. Since this smelter currently uses a secondary ventilation system for capture of converter fugitive emissions, it was assumed that the existing fans and ducting could be used in the new installation (page 6-14 of BID, Volume I). Kennecott disagreed that this existing hardware would be adequate for the new system, and supplied a capital cost estimate for new ductwork of $3.15 million. The company also provided a capital cost estimate of $7.23 million for a 28,300 acmm (1,000,000 acfm) baghouse to control secondary emissions from converter and matte and slag tapping operations. The EPA calculated the proportional cost of this baghouse attributable to the converter secondary control system based on a 10,000 acmm (330,000 acfm) gas flow through this system to be $4.1 million, about 8 percent higher than the cost of the 850 acmm (300,000 acfm) baghouse EPA assumed in its costing. This cost includes the additional fan capacity necessary to handle the gas flow to this baghouse. The cost of the air curtain secondary hoods themselves was estimated by Kennecott to be $1.5 million, slightly above EPA's $1.4 million estimate. The EPA reviewed Kennecott's capital cost estimates for accuracy and adherence to sound engineering principles, and found these estimates to be reasonable for the installation at the Utah smelter. Therefore, Kennecott's figure of $8.8 million has been incorporated into the revised costs used in EPA's cost analysis after proposal.

The EPA's proposal estimate of the annualized cost of converter controls was revised in a manner similar to those relating to the ASARCO smelter controls (Section 8.1.1). The figure for capital recovery was calculated using the assumption of 10 percent interest rate and a 20-year service life (0.1175 capital recovery factor), whereas Kennecott had assumed 15 percent interest and a 15-year service life (0.1710 capital recovery factor). The resulting figure of $1.0 million ($610,000 estimated by EPA at proposal) per year was added to Kennecott's estimate of operating cost of $1.0 million ($690,000 estimated by EPA at proposal) per year, to produce a revised total annualized cost for converter fugitive emission controls of $2.0 million per year.

Kennecott provided a combined estimate of total operating costs for controls on converter and matte and slag tapping operations, which EPA divided equally to apply to converter operations and matte and slag tapping operations. For maintenance and repair costs, Kennecott included an allowance of 7 percent of the total capital cost estimate. In its response memorandum issued for public comment (IV-B-32), EPA stated that it considered the 7 percent factor to be reasonable for control equipment, fans, and the air curtain secondary hoods, and so this factor was applied to the capital cost estimate for this equipment to calculate the maintenance and repair allowance. However, EPA applied a lower maintenance factor of 1 percent to the total estimated ductwork capital cost to calculate the maintenance and repair allowance for the new control system ductwork. The EPA used a lower figure because it has found that reasonable maintenance and repair costs for ductwork normally are somewhat lower than the estimate provided by Kennecott. Kennecott responded in comments on the memorandum that the 7 percent estimate for ductwork represents actual operating experience and should not be rejected (IV-D-812). The EPA believes, however, that its estimate is reasonable and has retained it for the revised cost analysis. In the case of the Utah smelter, the decision has been made that secondary emission controls would not cause a significant risk reduction, and a higher annualized cost estimate would not affect this decision. The revised total operating cost estimate for both converter and matte and slag tapping operations at Kennecott-Utah is $2.0 million per year, or $1.0 million per year for each of the two operations. The total annualized cost for converter controls, therefore, is estimated at $2.0 million per year, which includes a $1.0 million per year operating cost ($690,000/yr at proposal) and a $1.0 million per year capital recovery cost.

Kennecott's capital cost value for matte and slag tapping controls was considerably higher than EPA's estimate, primarily because Kennecott's figure included costs for new ductwork and increased fan capacity to the baghouse. The EPA's estimate at proposal assumed that only a baghouse sized for a flow rate of 4,500 acmm (150,000 acfm) and costing $1.8 million would need to be added into the existing capture system at Utah (cost includes 200 feet of ducting). Kennecott's baghouse cost estimate was based on the assumption that matte and slag tapping controls would result in a gas flow contribution of 11,300 acmm (400,000 acfm), at a proportional cost of $3.1 million. The EPA in its response memorandum considered this baghouse flow rate capacity to be much higher than necessary based on the configuration at the smelter, and used an estimate for the maximum total flow through the local hooding at the matte and slag tapping locations of 5,700 acmm (200,000 acfm). This capacity allows one reactor to undergo matte and slag tapping simultaneously or two reactors to undergo either matte or slag tapping simultaneously. Kennecott, in its comments on EPA's response memorandum, maintained that its sizing of the new baghouse for a 11,900 acmm (400,000 acfm) capacity was justified because there are times when both reactors would undergo simultaneous matte and slag tapping, and during such times a baghouse of this larger capacity would be required to meet the control requirements. The company felt that EPA's estimate reflected an unwarranted production restriction for the Utah smelter, and that EPA had rejected Kennecott's figure without presenting any supporting evidence. After a consideration of Kennecott's arguments, EPA still believes that its assumption reflects a reasonable, efficient production program at this smelter, and has retained its proportional baghouse cost estimate for matte and slag tapping of $2.16 million. As stated above, the decision to not require converter secondary emission controls at the Utah smelter (and to not impose matte and slag tapping controls on any smelter) would not be affected by increasing the control cost estimates. (However, EPA would consider this issue in more depth if a regulatory decision were dependent upon this cost estimate.)

The EPA had assumed at proposal that the fans and ductwork from the existing matte and slag tapping capture system would be salvageable for incorporation in the new control system. However, Kennecott's cost estimates indicated that new ducting and fan capacity would be required in the new system. The EPA has accepted the fan and ductwork costs totaling $5.6 million, adding this figure to the baghouse cost for EPA's revised total capital cost. Therefore, EPA's revised estimate of the total capital cost to install secondary emission controls on matte and slag tapping operations at Kennecott-Utah is $7.8 million.

The total annualized cost of matte and slag tapping controls was calculated as for converter controls, producing a capital recovery figure of $0.9 million per year and an operating cost of $1.3 million per year. (The EPA's proposal estimates were $0.2 million per year capital recovery and $0.3 million per year operating cost.) These revised figures are significantly higher than the proposal estimates principally because of the added fan and ductwork costs that were not included at proposal. The total of these estimates, $2.2 million per year, is EPA's revised annualized cost estimate for the Kennecott-Utah smelter.

Comment: Kennecott claimed that when the corrected annualized control costs and annual inorganic arsenic emission reductions for its Utah smelter are used in the calculation of cost effectiveness of smelter controls, the figure for secondary controls on converter operations increases to $2 million/Mg controlled (from EPA's proposal estimate of $185,400/Mg). The figure for fugitive controls on matte and slag tapping operations was estimated by the commenter to be $1.72 million/Mg controlled (versus EPA's proposal estimate of $302,400/Mg). The company's annualized cost estimate was $2.8 million/yr for converter controls and $2.9 million/yr for matte and slag tapping controls. The emission reduction resulting from these controls would be 1.4 Mg/yr (converters) and 1.7 Mg/yr (matte and slag tapping) (IV-D-634).

Response: The EPA evaluated Kennecott's estimates of the annualized costs of control and the arsenic emission reduction at the Utah smelter separately. Section 4.2.1 discusses the revision to EPA's proposal estimate of baseline converter secondary emissions, from 8.0 to 1.5 Mg/yr. This change led to a smaller amount of emission reduction due to NESHAP controls, from 7.0 to 1.4 Mg/yr. The EPA's estimate of the annualized cost of converter controls was revised after proposal, as discussed in the previous response, from $1.3 million/yr to $2.0 million/yr. These revised figures of 1.4 Mg/yr and $2.0 million/yr produce a revised cost per unit of emission reduction (for converter controls) of $1.4 million/Mg.

Since Kennecott's comments did not address the emission reduction effected by fugitive controls on matte and slag tapping operations, EPA has retained its proposal estimate of 1.7 Mg/yr. However, the annualized cost of these controls was revised from $0.51 million/yr to $2.2 million/yr, as discussed in the previous response. These figures of 1.7 Mg/yr and $2.2 million/yr produce a revised cost per unit of emission reduction (matte and slag tapping controls) of $1.3 million/Mg. Table 8-2 summarizes the estimated annualized costs, NESHAP emission reductions, and costs per unit of emission reduction discussed in this response.

I-8.1.2.2 Hayden Smelter.

Comment: Kennecott provided its estimates of capital, operating, and total annualized costs for best emission controls on converter operations at its Hayden smelter, which were somewhat higher than EPA's proposal estimates. The capital cost estimate was $8.0 million, the operating cost estimate was $1.2 million per year, and the total annualized cost estimate was $2.6 million per year. These estimates are in contrast to EPA's estimates at proposal of $6.7 million capital cost and $2.0 million per year annualized cost. The cost items cited by Kennecott were: new air curtain secondary hoods on each converter, new ductwork, a new baghouse, two new fans, and a new 61-meter (200-foot) stack (IV-D-634).

Response: The commenter did not supply individual cost estimates for each of the items, but only an estimate of total capital cost for the entire control system installation. Kennecott's capital cost estimate of $8.0 million for converter secondary controls is 19 percent higher than EPA's estimate at proposal ($6.73 million), and was accepted as a reasonable estimate. A revised figure for capital recovery ($940,000/yr) was calculated using EPA's basis of 10 percent interest rate and a 20-year service life. Kennecott's estimated operating cost ($1.2 million/yr) was accepted as reasonable and added to the revised capital recovery figure to produce a revised total annualized cost of $2.14 million per year, 8 percent higher than EPA's estimate at proposal.

I-8.1.2.3 McGill Smelter

Comment: Kennecott provided estimates of the capital and annualized costs to install and operate best emission controls on converter and matte and slag tapping operations at its McGill smelter. Kennecott estimated the capital cost as $9.0 million, the operating cost as $1.4 million per year, and the total annualized cost as $2.9 million per year. These estimates of capital and total annualized costs were 7 percent and 2 percent lower, respectively, than EPA's cost estimates at proposal for Kennecott-McGill. Cost items cited by Kennecott as being part of these total costs included converter air curtain secondary hoods, new secondary hoods at matte and slag tapping locations, new fans and ducting, a new baghouse, and new stack (IV-D-634).

Response: Kennecott's capital cost estimate was not broken down to apply to individual cost items, but was provided only as a single total figure. Also, the company's cost estimates represent the total

Table 8-2. ANNUALIZED COSTS AND ARSENIC EMISSION REDUCTIONS DUE TO SECONDARY EMISSION CONTROLS AT KENNECOTT-UTAH

Cost and Emission Parameters	Operation Controlled	EPA Proposal Estimate	Kennecott Estimate After Proposal	EPA Revised Estimate
Annualized Cost ($ million/yr)	Converter	1.3	2.8	2.0
	Matte and Slag Tapping*	0.51	2.9	2.2
Emission Reduction (Mg/yr)	Converter	7.0	1.4	1.4
	Matte and Slag Tapping*	1.7	1.69	1.7
Cost per Unit of Emission Reduction ($ million/Mg)	Converter	0.19	2.0	1.4
	Matte and Slag Tapping*	0.30	1.72	1.3

*Controls on secondary emissions from matte and slag tapping operations are not required in the final regulation; see Section I-1.1.

costs for secondary controls on both converter and matte and slag tapping operations, with no breakdown of the individual costs applicable to these two types of controls. To compare Kennecott's estimates to EPA's estimates at proposal, and to assess whether revisions to EPA's estimates were appropriate as a result of the company's comments, EPA separated Kennecott's cost estimate totals into individual estimates for converting operations and for matte and slag tapping operations.

As a first step in this process, a value for capital recovery was calculated using EPA's basis of 10 percent interest rate and a 20-year service life. For this calculation, Kennecott's $9.0 million capital cost estimate for all controls was accepted by EPA as being reasonable (7 percent lower than EPA's estimate at proposal). Since Kennecott's estimated annual operating cost of $1.4 million per year for all controls was also determined to be reasonable, the calculated capital recovery figure of $1.06 million per year was added to this operating cost to produce a revised total annualized cost for all controls of $2.5 million per year.

In order to apportion the revised annualized cost between converter secondary controls and matte and slag tapping fugitive controls, EPA retained its proposal estimate of $257,000 per year as the incremental total annualized cost of matte and slag tapping fugitive controls. This value was subtracted from the revised annualized cost estimate for all controls, producing an annualized cost for converter secondary controls only of $2.2 million per year.

The revised annualized cost calculated for converter secondary controls is 18 percent lower, at $2.2 million per year, than EPA's proposal estimate of $2.7 million per year. The same annualized cost estimate for matte and slag tapping controls of $257,000 per year assumed at proposal is retained in this updated cost analysis. (As indicated in previous responses, controls on fugitive emissions from matte and slag tapping are not required in the final NESHAP.)

I-8.1.3 Phelps Dodge Smelters

I-8.1.3.1 Morenci Smelter

Comment: Phelps Dodge claimed that the capital and annualized costs of installing converter secondary emission controls at the Morenci smelter were underestimated by EPA at the time of proposal. The company felt that EPA's estimates did not take into account the individual differences among smelters. Phelps Dodge provided a capital cost estimate of $16.9 million, in contrast to EPA's estimate of $8.5 million, to install controls to meet the proposed NESHAP at the Morenci smelter. This figure for controls on five converters includes $7.5 million for structural steel, ducts, and fans; and $9.4 million for a gas treatment plant (ESP's and lime spray pretreatment) sized for three converters blowing concurrently. The company said this estimate would increase if a waste handling system were included, or if space and power constraints proved to be a problem. Annualized costs were estimated by Phelps Dodge to be about $5.8 million per year, versus EPA's $1.9 million per year figure. This estimate consists of an annual operating cost of $2.9 million per year and a cost of capital of $2.9 million per year (IV-D-640).

Response: In order to assess the reasonableness of the Phelps Dodge cost estimates for the Morenci smelter, EPA requested a further cost breakdown in a request for information sent to Phelps Dodge after proposal (IV-C-417). Phelps Dodge supplied a capital cost breakdown for the actual costs the company had incurred in installing a secondary hood on the No. 7 converter at Morenci (IV-D-785). The company pointed out that the design of this hood is similar to air curtain secondary hood systems in its requirement for extensive modifications to existing duct and fan equipment. Thus, Phelps Dodge indicated that a requirement for air curtain secondary hoods on the converters at Morenci would mean that the existing secondary hooding system would have to be demolished. This is in contrast to EPA's assumption at proposal that the existing fans and ductwork at Morenci would be salvageable for use in a new air curtain secondary hood system. Since the capital costs for the secondary hood installed at the Morenci smelter are actual expenditures incurred by Phelps Dodge and the costs appear reasonable, Phelps Dodge's capital cost estimate of $7.5 million for air curtain secondary hoods on five converters at Morenci was used by EPA in updating its cost estimate.

Phelps Dodge's other capital cost component of $9.4 million covers the cost of the gas treatment part of the control system. The company has assumed that a lime injection system to control SO_2 would be required, and has further assumed that an ESP fabricated of stainless steel would be needed to minimize corrosion problems. These systems were considered necessary by Phelps Dodge because its studies showed a predicted acid dewpoint of 146°C (294°F) for the converter fugitive gas stream at Morenci. The EPA reviewed the information provided and found that the predicted acid dewpoint was greater than the reported operating temperature during the tests (IV-D-785). Owing to the absence of any statements regarding actual corrosion problems with the fugitive gas system ductwork at Morenci and the possibility for in-situ formation of acid sulfate during these tests, EPA concluded that the information submitted did not demonstrate the need for corrosion-resistant materials and lime injection. Furthermore, EPA has observed converter secondary control systems at two smelters (ASARCO's Tacoma and El Paso smelters), and has not found acid-based corrosion to be a problem in these systems. These observations have been confirmed in recent conversations with ASARCO representatives (IV-E-80, IV-E-81). Concentrations of sulfur dioxide are moderate (several hundred to several thousand ppm), and the moisture content and gas temperature are near ambient levels. These gas stream characteristics are similar to the characteristics reported for the converter fugitive gas system at Morenci. For this reason, EPA believes that the converter secondary control system can be operated safely above the acid dew point temperature of the gas stream, so that the expensive lime injection and corrosion-resistant ESP system would not be necessary. The capital costs of a baghouse and a carbon steel ESP sized for this system were compared, with the object of applying the higher of the two costs to EPA's revised total capital cost estimate for this system. This was done so that the presumed "worst case" costs for this facility would be considered in the Agency's determination of the reasonableness of controls. Since an ESP fabricated of carbon steel would cost approximately $2.5 million (IV-E-65), EPA applied its proposal estimate for a fabric filter of $5.47 million to the calculation of total capital cost. This fabric filter cost is added to the estimated cost for five air curtain secondary hoods, producing a revised total system cost estimate of approximately $13.0 million. In summary, the revised capital cost estimate is higher by $4.5 million than EPA's estimate at proposal. The largest part of the difference is attributable to demolition and replacement of existing ductwork.

As with the cost estimates for the smelters discussed earlier in this section, EPA calculated the capital recovery figure from this revised capital cost estimate assuming a 10 percent interest rate and a 20-year service life (capital recovery factor 0.1175). The resulting capital recovery figure of $1.52 million per year is considerably lower than the Phelps Dodge estimate of $2.88 million per year, which was based on a $16.9 million capital cost and an assumed 15 percent interest rate and a 15-year service life. Phelps Dodge's estimate for electric power costs ($1.32 million/yr) was adjusted to apply to a baghouse rather than an ESP, producing an estimate of $1.22 million per year. Maintenance costs were calculated by Phelps Dodge as 5 percent of capital ($844,000 per year), and operating labor was estimated at $35,000 per year. These assumptions for the cost of maintenance and operating labor were accepted by EPA for its revised estimate, yielding a lower figure for maintenance and operating labor (based on the lower total capital cost) of $683,600 per year. Therefore, after considering the comments of Phelps Dodge on the cost estimates made by EPA at proposal, a revised annualized cost estimate for converter controls at Phelps Dodge-Morenci of $3.43 million per year has been calculated. This figure is about $1.5 million per year higher than EPA's proposal estimate. The difference is attributable mainly to higher capital recovery (due to higher capital cost) and to higher costs to operate and maintain the system than previously estimated.

Comment: Phelps Dodge commented that when the company's estimates for annualized control costs and annual arsenic emission reductions for its Morenci smelter are used to calculate the cost effectiveness of NESHAP converter controls, the resulting figure of $21 million/Mg controlled is well beyond the upper limit of $700,000/Mg cited by EPA as an approximate cutoff above which controls would not be reasonable. The company claimed that the annualized cost of these controls would be approximately $5.8 million per year (see previous comment), and that fugitive arsenic emissions from the converters would be reduced by 0.035 kg/h (0.078 lb/h) or 0.30 Mg/yr (0.33 tons/yr) (IV-D-640).

Response: As discussed in previous comments, EPA has evaluated the company's estimates and made adjustments to the figures used at proposal to judge the reasonableness (cost of operation versus emission reduction achieved) of converter controls. After evaluating Phelps Dodge's basis for its annualized cost estimate (previous response), EPA increased its estimate beyond the estimate at proposal by 80 percent to $3.43 million per year. In its response to the comment by Phelps Dodge on arsenic emission rates from the Morenci smelter (Section 4.3.1), the Agency lowered its proposal estimate of baseline converter secondary emissions, and hence the amount of emission reduction calculated to be achievable through the use of NESHAP controls on converter operations. The EPA's revised emission reduction estimate is 1.7 Mg/yr, as opposed to its estimate at proposal of 6.3 Mg/yr. These figures of $3.43 million/yr annualized cost and 1.7 Mg/yr arsenic emission reduction were divided to obtain a revised EPA estimate of $2.02 million/Mg of arsenic controlled.

Table 8-3 presents the converter secondary control costs estimated by EPA at the time of proposal, cost estimates provided by commenters after proposal, and current EPA estimates for these costs revised as a result of public comments. All estimates are higher than at proposal, with the exception of the Kennecott-McGill costs, which are lower by about 18 percent.

I-8.1.3.2 Ajo Smelter

Comment: Phelps Dodge felt that the costs of installing and operating a system to cool the reverberatory furnace offgases and collect inorganic arsenic at the Ajo smelter would be prohibitive, with a capital cost of about $3.0 million and an annualized cost of $5.0 million per year. The EPA had discussed in the preamble to the proposed standards (48 FR 33140) the possible need to consider this control option for Phelps Dodge-Ajo, should specific changes to the reverberatory furnace (conversion to oxy-sprinkle smelting) and the installation of acid plant controls not be carried out under a consent decree with the State of Arizona. The EPA's cost estimates at proposal for this option were $1.5 million capital cost and $1.6 million per year annualized cost. Phelps Dodge did not provide a breakdown of its cost estimates (IV-D-640).

Response: In order to evaluate the cost estimates submitted by Phelps Dodge after proposal, EPA requested a breakdown and rationale for these estimates in an information request sent to the company (IV-C-417). Phelps Dodge responded with an itemized cost breakdown indicating capital costs totaling about $3.6 million and an annualized cost of approximately $3.6 million per year for the items considered necessary by the company for this control installation (IV-D-790). Capital cost items included an evaporative cooler, fiber glass ducting, a stainless steel ESP with lime spray, and flue burners for offgas reheating. Annualized cost components included water, electrical power, and natural gas; lime treatment; labor and maintenance costs; and capital recovery costs (at 17.1 percent). The company stated that these cost estimates were conservative because they did not consider several items, including demolition of existing equipment, costs of electrical and mechanical equipment and structural steel for the cooler, engineering costs, and the costs for a sludge and/or dust treatment plant.

The EPA has addressed in Section I-6.2 the issue of applying the option of cooling gas streams to increase arsenic collection. As discussed in the first response, the Agency is not presently in a position to make a final determination concerning the technical feasibility of cooling gas streams to various temperatures without creating

Table 8-3. COST ESTIMATES FOR CONVERTER SECONDARY ARSENIC CONTROLS

Smelter	Capital Cost Estimates ($1,000)			Annualized Cost Estimates ($1,000/yr)		
	EPA Proposal	Company Comments	EPA Revised	EPA Proposal	Company Comments	EPA Revised
ASARCO-Hayden	1,700	3,600	3,660	408	1,350	798
ASARCO-El Paso	1,375	1,850	1,850	307	727	379
Kennecott-Utah	5,200	8,800	8,800	1,300	2,800	2,028
Kennecott-Hayden	6,730	8,000	8,000	1,980	2,600	2,140
Kennecott-McGill	8,760	9,000*	7,150	2,700	2,900*	2,200
Phelps Dodge-Morenci	8,530	16,900	12,970	1,910	5,800	3,430

*These cost estimates submitted by Kennecott are for secondary emission controls on both converter operations and matte and slag tapping operations. Controls on matte and slag tapping operations are not required under the final regulation; see Section I-1.1.

a corrosion potential, or to accurately predict the amount of arsenic reduction that can be expected in various control situations. Section I-6.2 also reviews the Agency's estimate of the health risk associated with the smelting furnace process stream at Phelps Dodge-Ajo. Table 6-2 indicates that a very low annual cancer incidence is estimated to result from this particular emission stream due to inorganic arsenic (0.0034 incidence per year). Thus, even if all of the arsenic in this gas stream were collected before its release to the atmosphere, the reduction in risk would be so small as to make this control option unreasonable.

For these reasons, EPA is not now requiring that gas stream cooling be utilized at the Ajo smelter to reduce inorganic arsenic emissions. Also, in light of the uncertainty associated with this issue, and since this option would not be selected regardless of the estimated costs to implement it, the Agency is retaining the control cost estimates developed at proposal rather than accepting Phelps Dodge's higher estimates.

I-8.2 COMMENTS ON ECONOMIC IMPACTS

I-8.2.1 Basis for Economic Analysis Unexplained

Comment: The State of New York commented that EPA's use of cost considerations is totally unexplained. The comments specifically noted that EPA did not indicate what level of economic hardship was considered sufficient to preclude regulation, what standards of review are used, and what financial information was considered. The commenter said EPA has apparently accepted wholly and on faith the general assertions of economic vulnerability made by industries in the source categories the Agency has decided not to regulate (IV-D-698).

Response: Historically, in the case of nonthreshold pollutants, when complete elimination of a pollutant is not practical, EPA has used cost considerations as one of several decision tools. In this regulatory development, no specific level of economic hardship was used as a criterion. However, EPA did investigate all of the technologies felt to be effective from an engineering standpoint. The EPA does not accept wholly and on faith general assertions of economic vulnerability made by industries in the source categories under investigation. On the other hand, EPA did not wholly reject information merely because it was provided by industries in these source categories. Within the time and resource constraints in effect, EPA actively sought information from any and all parties likely to have specific and relevant economic and financial information, and undertook independent analyses of economic impacts. A partial list of information sources that were used includes the following: direct contact with many of the affected plants and companies; contact with trade associations; a review of corporate annual reports and reports to the Securities and Exchange Commission (SEC Form 10-K); review of independent cost studies of the copper smelting industry; a review of reports by other government offices, such as OSHA; a literature review of trade publications, and so forth. Also, notices in the Federal Register and the public comment period(s) are additional means that assist in soliciting specific and relevant information from interested parties.

The EPA believes that projections are a reasonable means of determining the economic impact of controls. Furthermore, the alternative of making decisions on appropriate control levels in the absence of any information on the economic and related community consequences is, in the Administrator's judgment, unreasonable.

I-8.2.2 Insufficient Economic Data

Comment: The Sierra Club stated that the proposal should include sufficient economic data for the public to judge the economic feasibility and costs of controls, including income figures for all operations at a smelter such as gold and silver production. In addition, the actual costs of plant closure should be detailed for each smelter and compared to benefits (e.g., health cost savings) (IV-D-608, IV-F-1, IV-F-2).

Response: All of the costs that have been accumulated must be estimates of future outlays. These include labor costs which are subject to union negotiation, utility costs which are subject to public utility commission regulation, and taxes which change according to governmental budgets. Even income from precious metals is subject to arbitrary allocation among mine, smelter, and refinery. Furthermore, the financial health of the industry depends heavily on the price of copper, which changes from day to day.

Shutdown costs are even more variable. They depend upon union contract provisions, the generosity of the company over and above contract considerations, and the geographic location of the plant. (A company with a small plant in a large city could be considered to have less of a "moral obligation" than if the plant were the primary support for a small, isolated community.)

In short, costs cannot be estimated with complete accuracy. Nevertheless, in the interim since proposal the accuracy of EPA's cost estimates has been considerably improved. The economic impacts on the industry based on the revised cost estimates are discussed in Appendix F.

I-8.2.3 Economic Impacts Versus Health Risks

Comment: The Chemical Manufacturers Association (CMA) commented on EPA's consideration of economic impacts in assessing the acceptability of residual risks after application of BAT. The CMA stated that the language of the July 20, 1983, Federal Register notice implied that the only economic impact EPA is prepared to consider at this point is closure. The CMA thought that this was an unduly restrictive approach and that EPA is not justified in requiring large expenditures to achieve negligible reductions in health risk. Consequently, they recommended that EPA consider a broader range of economic impacts in the analysis (IV-D-617).

Response: The EPA agrees, in general, with CMA that large expenditures are not justified when public health risk is low and when the ability to reduce the risk is limited. In the case of certain facilities, however, EPA believes that the magnitude of estimated risk warrants the implementation of affordable controls that can significantly reduce public exposure to inorganic arsenic emissions. Both the proposed and final standard are based on the best emission controls that are available and can be applied without causing plant closure or imposing costs that far exceed any public health benefit. A number of considerations were weighed by EPA in selecting the level of the proposed standard. Among these factors was the economic impact of further reducing the risks. The preamble to the proposed standards addressed only the closure impact since that was the principal anticipated impact of the identified beyond BAT controls.

As previously discussed, following proposal EPA revised its estimate of emissions and control costs at the 14 primary copper smelters and reassessed the economic impact of the control costs. The standard was selected considering the magnitude of the risks, the costs and availability of further controls and the associated risk reduction potential, the environmental impacts, and the potential societal impacts of the alternative control measures. Consequently, EPA believes that the standard does not impose control costs that are disproportionate to the risk reduction achievable.

I-8.2.4 Financial Relief for Affected Groups

Comment: The Sierra Club also recommended that EPA consider requiring capital investment set-asides which would be available for smelter capital improvements when EPA re-examines BAT requirements after 5 years. This would provide smelters that otherwise could not afford required controls with a means of maintaining BAT controls on their operations (IV-F-1, IV-F-2). The NRDC suggested that some form of financial relief be established to assist communities that are at particular risk from smelter arsenic emissions (IV-F-1).

Response: The capital investment set-aside concept appears to be similar to the Superfund monies used for cleaning up hazardous waste sites. However, the Superfund was established by an Act of Congress and is dispensed as needed to clean up existing sites. Since there are no statutes governing capital investment set-asides for future air pollution control, the principle cannot be enforced. Even if it were enforceable, there is no way to determine the size of the payments to be set aside.

Heretofore, governmental financial relief has taken the form of removing hazards by digging up contaminated soil or relocating the residents of the area. In the case of air pollution, financial relief actions are not clearly definable and funds, private or public, are better spent for control of emissions.

I-9.0 COMPLIANCE PROVISIONS

I-9.1 PANEL APPROACH

Comment: ASARCO and Phelps Dodge felt that the panel approach to secondary hood performance optimization suggested by EPA in the proposal preamble would be costly and time-consuming, and would likely lead to disputes. The companies themselves would naturally want the hoods to work well and therefore should be allowed to develop hood operating parameters on their own through trial and error. A list of proposed operating parameters could then be submitted to EPA for its approval. If, however, EPA decides to go ahead with this approach, the panel should contain at least one neutral member to aid the panel in reaching agreement (IV-D-620, IV-D-640, IV-F-1, IV-F-2).

Response: The potential use of a panel of observers to evaluate hood performance was discussed in the July 20, 1983, Federal Register notice of proposal (48 FR 33148). It was suggested that the panel could be composed of three or more persons, including representatives of industry, EPA, and a local air pollution control agency. The mission of this panel would be straightforward, to assist in the optimization of a new air curtain secondary hood's operation, through observations of the hood under various operating conditions.

The Administrator believes that visual observations, although subjective, are the most effective way to assess an air curtain hood's overall performance. This method is relatively quick, inexpensive, and uncomplicated compared to alternative techniques such as the tracer mass balance technique. The requirements of the standard do not preclude an owner or operator's conducting studies or performing assessments on the best operation of an air curtain secondary hood. In fact, the Administrator believes that such studies would likely expedite EPA's own evaluation of the hood's performance. However, the final operating conditions should be determined by the Agency because the optimization process is a further step in the development of the regulation. This part of the regulation cannot be established until the equipment required under the standard is installed and operating. The specific requirements that will establish optimum capture of converter secondary emissions will then be proposed in the Federal Register and established after consideration of public comments.

The suggestion of these commenters that the members of the panel would likely be biased (and presumably make substantially different observations as a result of this bias) is not considered a reasonable one by the Agency. The Administrator would consider any significant discrepancies among observers, should they occur, in selecting the optimum operating conditions. Past experience at ASARCO-Tacoma indicates that the observations of two observers were in close agreement, and EPA does not foresee that the observations of three (or more) persons would be likely to vary significantly. In the proposal for public comments, the various individual observations will be discussed, providing an opportunity for commenters to state objections concerning any discrepancies.

In summary, EPA still considers the visual observations approach to hood operational optimization the preferred method, although this could be carried out either by EPA personnel alone or by a group from various organizations.

Comment: NRDC and USWA expressed their support for the panel approach, but felt its makeup and function should be expanded. To assure balance with respect to the interests represented on the panel as proposed (representatives of industry, EPA, and local air pollution control agencies), the size of the panel should be increased to include a representative of the employees and of the public. Also, the additional functions of assisting in enforcement and helping to identify additional control opportunities would be useful additions to the panel's charter. The members of the panel from the public and the union should be compensated for their participation, at least to cover expenses (IV-D-708, IV-D-710).

Response: The Administrator considered the suggestion to enlarge the size and expand the charter of the proposed panel, and determined that this would be beyond the scope of EPA's intentions when it suggested the panel approach. The panel was not intended as an advisory committee, but as a temporary group convened to accomplish a specific short-term goal. As stated in the previous response, EPA views the establishment of operating conditions for air curtain secondary hoods as part of the regulatory development. After examining the options available for accomplishing this end, the Agency concluded that a group of limited size with a limited mission would be the most expeditious means of establishing the best control of converter secondary emissions at smelters with high potential arsenic emissions. Since there will be opportunities for all interested parties to examine and comment on the proposed optimum conditions for each regulated primary copper smelter, it is not necessary to enlarge the group and risk losing efficiency while adding to the expense of the process.

The EPA further believes that the functions of enforcement and identification of control opportunities should be retained by the Agency. Opportunities for control are determined during development of the regulation and in subsequent reviews, with sufficient opportunity for dialogue with concerned parties. Also, EPA feels it can enforce the provisions of the regulation at the limited number of facilities without deputizing other parties. Since the panel may contain a representative of the owner or operator of the facility, an enforcement role would be inappropriate.

I-9.2 OPERATION AND MAINTENANCE REQUIREMENTS

Comment: The Washington State Department of Ecology (DOE) recommended that requirements for good operation and maintenance for process controls be included in the final regulation (IV-D-622).

Response: The EPA is in agreement with DOE and believes that requirements for maintaining process, conveying, and emission control equipment in a condition that will optimize control of emissions would be an important feature of the final regulation. Therefore, the final standard regulating existing and any new primary copper smelters (and arsenic production facilities; see Section II-2-3), contains provisions requiring operating and maintenance practices that will minimize inorganic arsenic emissions.

I-10.0 TEST METHODS AND MONITORING

I-10.1 PROPOSED METHODS 108 AND 108A

I-10.1.1 Method 108 More Appropriate for Measuring Arsenic

Comment: The New Jersey Department of Environmental Protection (NJDEP) commented that EPA Reference Method 108 would be a more appropriate method than Method 5 for evaluating emission controls or compliance with the standards. The NJDEP noted that Method 5 might not measure all arsenic emissions since part of the material will be in the vapor phase in a hot gas stream. The commenter also recommended that the material collected in the impingers in the Method 5 train (back-half catch) be included in the measurement to obtain a valid measure of total arsenic emissions (IV-D-641).

Response: The commenter's recommendations for measuring inorganic arsenic concentrations incorrectly imply that the standard requires a determination of total arsenic emissions. The standard for the collection of secondary inorganic arsenic emissions from primary copper smelters is based on a total particulate concentration limit, not an inorganic arsenic limit. At proposal, EPA considered developing an emission limit specifically for inorganic arsenic and recognized several difficulties in developing such a standard. A numerical emission limit specifically for inorganic arsenic would have to account for the potential variability in the inorganic arsenic content of secondary emissions at copper smelters. An inorganic arsenic emission limit would only establish an upper limit on inorganic arsenic emissions; hence, an inorganic arsenic limit based on current data might not require application of the best emission controls if other ore concentrates were processed. Although a percent reduction format would require the application of best controls regardless of the level of inorganic arsenic in the feed materials, high collection efficiency might not be continuously achievable for the entire range of inorganic arsenic concentrations that could occur in captured secondary emission gas streams.

In contrast, there are several advantages to using a total particulate emission limit to regulate inorganic arsenic emissions. First, total particulate emissions from primary copper smelter operations remain relatively constant regardless of the inorganic arsenic content of the ore concentrate; thus, a total particulate emission limit would require the use of best emission controls for all ore concentrates regardless of variations in the inorganic arsenic content of the feed. Second, Method 5 can be used to determine compliance. Method 5 is a simple, well understood test method, and testing groups already are equipped to apply this method to gas streams at copper smelters. For these two reasons, EPA developed the standard for collection of inorganic arsenic emissions based on a total particulate emission limit. Since determination of compliance requires measurement of total particulate matter, the commenter's suggestions concerning the measurement of inorganic arsenic have not been incorporated into the final standard.

I-10.1.2 Problems With Methods 108 and 108A

Comment: ASARCO and Phelps Dodge commented that there are several problems with proposed Reference Method 108, Determination of Particulate and Gaseous Arsenic Emissions, and Method 108A, Determination of Arsenic Content in Ore Samples from Nonferrous Smelters (IV-D-620, IV-D-640, IV-F-1, IV-F-2). They felt that sampling methods currently used by the two companies should be accepted by EPA as equivalent methods. The Texas Air Control Board (TACB) also felt that Method 108A presents problems. The following discussion lists the problems the commenters believe to be associated with the Methods.

1. The sampling train used in Method 108 contains impingers for the collection of SO_2, with analysis performed using sodium hydroxide and a phenophthalein indicator. This technique is different from the traditionally used Method 6, which requires titration with a standard barium solution to a thorin indicator end point. ASARCO felt that this new method for sampling SO_2 had not been adequately field-tested, and would likely be an inaccurate measure of SO_2 content in the arsenic-containing gas stream. This SO_2 sampling method should not be included until its accuracy has been verified.

2. The use of a Parr Digestion Bomb in Method 108A to dissolve arsenic in samples of matte and slag presents several problems. First, the price of $150 for the bomb introduces unnecessary expense into the Method. Second, the bomb must be sealed and accurately heated for 2 hours, which is much longer than the digestion period in a method currently in use at ASARCO, which does not utilize the bomb. Finally, there are very real safety hazards associated with the Method and, in fact, explosions have occurred during its development. This explosion potential appears to be related to the use of a cellulose filter in place of a glass fiber filter. ASARCO suggested, and Phelps Dodge endorsed, an alternate method that does not require the digestion bomb, takes only 20 minutes, and is safe. The TACB commented that the digestion bomb presents a safety hazard due to acid under pressure, and small sampling programs might find that the purchase of multiple bombs presents a cost burden (IV-D-153).

3. The atomic absorption spectroscopy technique (AA) required in both Methods is not accurate for the analysis of arsenic in copper concentrates containing more than 4 percent arsenic, which occurred at ASARCO-Tacoma. The ASARCO representative suggested a protocol that his company uses for analyzing concentrates with relatively high concentrations of arsenic (greater than 2 percent). The commenters also pointed to a discrepancy between the form of AA used in each of the Methods, graphite furnace AA in Method 108A and arsine generation AA in Method 108. It was felt that the two methods should agree in terms of the AA method specified, or preferably, that a laboratory be allowed to evaluate and choose the AA technique that best fits its sample matrices and budget (the graphite furnace accessory is four times the cost of arsine generation equipment). The reference solution produced in the Methods may not be fully oxidized to the pentavalent arsenic necessary for accurate analysis; a technique to assure full oxidation should be provided in the Methods. Finally,

AA techniques have been found to suffer from interferences in these applications. An alternative procedure to AA was suggested by ASARCO, claimed to be less expensive and to have fewer interference problems than AA procedures.

Response: Since the emission standard for primary copper smelters is stated in terms of total particulate matter, Method 108 for determining arsenic emissions applies at this time only to glass manufacturing plants (to which an arsenic emission limit for glass melting furnaces applies). The SO_2 collection and analysis requirements in Method 108 have been deleted. Method 108A for determining the arsenic content of ore samples will apply to analysis of matte and slag samples at primary copper smelters.

In Method 108A, two of the three factors involved in using the Parr digestion bomb (cost and sample dissolution time) are not considered to represent excessive problems. The price of the digestion bomb should not represent an intolerable expense since its cost is a relatively small proportion of the total sampling and analytical equipment costs. The problem of an explosion potential when using cellulose filter paper is unique to Method 108 which is not applicable to primary copper smelters. Since little or no arsenic is present in the insoluble particulate matter in emissions from glass furnaces, the digestion procedure was eliminated from Method 108.

For samples containing more than 4 percent arsenic, acceptable accuracy with the AA can be obtained by appropriately diluting the sample (ASARCO's Tacoma smelter, recently closed, was the only smelter that processed concentrates with this level of arsenic). Method 108A has been modified since proposal to allow the tester the option of choosing between a graphite furnace and an arsine generator for the analysis. The potential errors that could result in the reference solutions because of incomplete oxidation of arsenic to the pentavalent state have been eliminated by a requirement for the stock reference solution to be heated after introduction of the acid. Methods 108 and 108A require a mandatory check for matrix effects using the method of standard additions. If this check reveals matrix interferences, then all samples must be analyzed by standard addition to compensate for this difference.

The alternative analytical procedure recommended by ASARCO may be potentially approvable as an alternative method. If ASARCO wishes to use their recommended alternative procedure, a clear, easy-to-follow, description of the procedure should be submitted along with any rationale or data necessary to show the validity of the alternative method in the particular application. (The specific information needed for evaluation of the protocols was described in a letter to ASARCO [IV-C-487]. After the information is submitted EPA will evaluate the suggested procedure.)

I-10.1.3 Misprint

Comment: The last line of paragraph 5.1 of Method 108A should read "mg/g," not "g/g" (IV-D-145).

Response: The last line should read "g/g" as appeared in the proposal.

I-10.2 PROPOSED OPACITY MONITORING REQUIREMENTS

Comment: ASARCO and Phelps Dodge felt that transmissometers as proposed in §61.176 (§61.175 in final regulation) to continuously measure outlet stream opacity would not provide a reliable way to monitor compliance with the emission limit. The commenters discussed several factors that argue against the use of continuous opacity monitoring. First, the accuracy of these readings depends heavily on the size distribution of the particulate matter in the gas stream, and this distribution may vary due to the blending of gases from various sources, without the mass concentration being significantly affected. Also, the opacity level to be monitored would generally be near the lower detection limit of the instrument. ASARCO referred to frequent maintenance problems it has had with its existing transmissometers. The commenters suggested the alternative of keeping control equipment maintenance records and performing annual Method 5 source sampling audits to verify compliance (IV-D-620, IV-D-640, IV-F-1, IV-F-2).

Response: As discussed in the preamble to the proposed standards (at 48 FR 33149), the purpose of continuously monitoring the emission gas streams is to ensure that the equipment used to control arsenic emissions is properly operated and maintained to meet the emission standards. Records from opacity monitors would thus serve as an indicator that the control equipment was operating as it was designed and had operated during a successful performance test. The opacity records cannot, however, be used to determine the compliance status of a source with respect to a numerical emission limit. An emission stream showing a chronically high opacity level would be a candidate for a Method 5 test to verify its compliance status. The suggestion of an annual Method 5 test as a replacement for opacity monitoring is not considered an acceptable alternate, primarily because 1 year is too long a period to wait for information on the operating and maintenance status of the control equipment. More frequent Method 5 tests would be expensive as well as an inconvenience for a facility.

The EPA agrees with the commenters that significant fluctuations in the size distribution of particulate emissions could cause a variation in the observed opacity level. However, the opacity increases due to particle size changes are expected to be small relative to the increases that would result from malfunctioning or poorly maintained equipment. The monitoring requirement has been revised to include provisions that account for minor excursions in opacity levels and that allow for reestablishment of the opacity limit during any subsequent emission test that demonstrates compliance with the standard. One-hour average opacity levels would be determined over a period of at least 36 hours during which the processes and control equipment were operating normally. The highest of these 1-hour opacity averages would be determined, and 5 percent opacity added to this level to create a reference opacity level. One-hour average opacity levels subsequent to the test in excess of the reference level would indicate that the control device may no longer be achieving the particulate emission limit. At this point a Method 5 test would be necessary in order to determine actual compliance.

Opacity levels associated with particulate concentrations of 11.6 mg/dscm (0.005 gr/dscf) are likely to be close to or at the detection limit of transmissometers. Continuous opacity monitoring was proposed not as a surrogate compliance method but, as stated in the proposal preamble, as an indicator of the operation of the emission control device. Opacity monitoring has been shown to be a useful means of indicating significant changes in the level of particulate control resulting from operation or maintenance practices. To ensure that opacity monitoring does serve as an indicator of significant changes in performance, the monitoring requirement was revised as described above. The revisions which consider the instrument's imprecision and use a larger data base are believed to address the special problems presented by low concentration gas streams. The EPA believes that reference opacity levels determined according to the requirements of 61.175(c) will be useful for evaluating operation and maintenance of the control device.

The EPA has found that excessive maintenance and downtime should not be a problem with state-of-the-art opacity monitoring equipment. Available information indicates that transmissometers that satisfy 40 CFR 60 Appendix B specifications have repeatedly demonstrated more than 95 percent availability when properly operated and maintained (IV-J-59).

I-10.3 WAIVER OF SAMPLING REQUIREMENTS

Comment: Magma Copper Company stated that it had no objection to the proposed requirement, in §61.175(d), (e), and (f), for the collection and subsequent analysis of daily grab samples of matte, slag, and total smelter charge to determine initially a smelter's converter arsenic charging rate and furnace tapping rate with respect to the cutoff levels for applicability. However, this commenter felt that the continued practice could prove burdensome for a smelter that fell well under the cutoffs. The company questioned whether the waiver of emission tests referred to in proposed §61.175(a)(4) [final §61.174 (a)(4)] could be sought with regard to the sampling requirements for a smelter that had very low arsenic input rates (IV-D-619).

Response: The waiver of emission tests discussed in §61.13, and referred to in §61.175(a)(4) of the proposed regulation for low-arsenic copper smelters, applies to sources that are covered by hazardous air pollutant standards and are required to demonstrate compliance with the standards through periodic testing of emissions. Thus, this reference in the regulation does not refer to the sampling requirements for demonstrating applicability.

The EPA agrees that the daily collection and monthly analysis of grab samples would prove burdensome for a smelter that fell well under the final applicability cutoff of 75 kg/h (164 lb/h) converter arsenic charging rate (the smelting furnace arsenic tapping rate cutoff no longer applies). Paragraph 61.174(g) has been included in the final regulation to permit an owner or operator to petition the Administrator for a modified sampling schedule if the analyses performed in the first year of the standard show the source to have a very low arsenic processing rate in relation to the cutoff value. An example of a modified sampling schedule would be weekly, instead of daily, grab samples being collected to form the composite monthly samples.

I-11.0 REFERENCES*

Item Number in Docket A-80-40	
II-A-71	Vervaert, A. and J. Nolan, U.S. Environmental Protection Agency and Puget Sound Air Pollution Control Agency. Log Book Nos. 1 and 2, Observations of Converter Secondary Hood Test at ASARCO-Tacoma. January 18-22, 1983.
II-D-43	Letter and attachments from Malone, R.A., Kennecott Minerals Company, to Farmer, J.R., U.S. Environmental Protection Agency. March 16, 1983. Response to Section 114 request for information.
II-J-13	Occupational Exposure to Inorganic Arsenic; Supplemental Statement of Reasons for Final Rule, 29 CFR Part 1910. Occupational Safety and Health Administration (OSHA). 48 FR 1864. January 14, 1983.
III-A-1	National Emission Standards for Hazardous Air Pollutants; Proposed Standards for Inorganic Arsenic, 40 CFR Part 61. Proposed rule and announcement of public hearing. U.S. Environmental Protection Agency. 48 FR 33112. July 20, 1983.
III-B-1	Inorganic Arsenic Emissions from High-Arsenic Primary Copper Smelters - Background Information for Proposed Standards (Draft EIS). U.S. Environmental Protection Agency. Research Triangle Park, N.C. Document No. EPA-450/3-83-009a. April 1983.
III-B-2	Inorganic Arsenic Emissions from Low-Arsenic Primary Copper Smelters - Background Information for Proposed Standards (Draft EIS). U.S. Environmental Protection Agency. Research Triangle Park, N.C. Document No. EPA-450/3-83-010a. April 1983.
IV-A-4, IV-A-5	Evaluation of an Air Curtain Hooding System for a Primary Copper Converter, Volumes I and II. Prepared by PEDCo Environmental, Inc., for U.S. EPA, Research Triangle Park, N.C. Document Nos. EPA-600/2-84-042a and b. December 1983.

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*Appendix A contains a listing of public comment letters on the proposed standards.

Item Number in Docket A-80-40	
IV-A-6	Arsenic Non-Ferrous Smelter Emission Test Report, Arsenic Sampler Comparison ASARCO, Incorporated, Tacoma, Washington. Prepared by PEDCo Environmental, Inc., for U.S. EPA, Research Triangle Park, N.C. EMB Report 83-CUS-20. January 1984. pp. 2-33 and 2-34.
IV-A-9	Costello, T.V. and Gracey, J.W. Analysis of the Effect on the Arsenic Markets if the ASARCO-Tacoma Primary Copper Smelter Ceases Arsenic Production. JACA Corporation. Ft. Washington, PA. March 1984.
IV-A-10	Visible Emissions Converter Secondary Hooding. Prepared by Radian Corporation, for U.S. EPA, Research Triangle Park, N.C. EMB Report 81-CUS-17. May 1982.
IV-B-6	Letter from Vervaert, A.E., U.S. Environmental Protection Agency, to Zimmer, C., PEDCo Environmental, Inc. August 25, 1983. Transmittal of main stack arsenic emission estimates for ASARCO-Tacoma.
IV-B-10	Letter and enclosures from Vervaert, A.E., U.S. Environmental Protection Agency, to Schewe, G.F., PEDCo Environmental, Inc. October 28, 1983. Technical background on low-level arsenic emission estimates for ASARCO-Tacoma.
IV-B-26	Memorandum from Whaley, G., Pacific Environmental Services, Inc., to Docket No. A-80-40. January 24, 1984. Report on trip to Kennecott-Utah smelter on November 1, 1983, to observe secondary emission capture systems.
IV-B-30	Memorandum from Vervaert, A.E., U.S. EPA, to Layland, D., U.S. EPA. April 4, 1984. Arsenic dispersion calculations for the ASARCO-Tacoma primary copper smelter.
IV-B-32	Memorandum from PES Low-Arsenic Project Team to Chaput, L., Standards Development Branch, U.S. EPA. August 31, 1984. Revised cost and emission estimates for low-arsenic smelters.
IV-B-35	Memorandum from PES, Inc., to Chaput, L., Standards Development Branch, U.S. EPA. April 3, 1985. Plant visit to ASARCO, Inc., copper smelter at El Paso, Texas.

Item Number in Docket A-80-40	
IV-B-36	Memorandum from Meyer, J., PES, Inc., to Docket A-80-40. April 26, 1985. Statistical Analysis of Sulfur Recovery Data for ASARCO-Hayden.
IV-C-3	Letter and enclosures from Ajax, R.L., U.S. Environmental Protection Agency, to Hawkins, D., Natural Resources Defense Council. August 4, 1983. Transmittal of BID reference materials requested by NRDC.
IV-C-48	Letter from Elkins, C.L., U.S. Environmental Protection Agency, to Doniger, D.D., Natural Resources Defense Council. August 24, 1983. Response to NRDC's request for delay of public hearings and for technical assistance.
IV-C-120	U.S. Environmental Protection Agency, Region X. News release to the public regarding new data on arsenic emissions from ASARCO-Tacoma. October 20, 1983.
IV-C-416	Letter and enclosures from Farmer, J.R., U.S. Environmental Protection Agency, to Malone, R.A., Kennecott Minerals Company. February 15, 1984. Section 114 request for information.
IV-C-417	Letter and enclosures from Farmer, J.R., U.S. Environmental Protection Agency, to Rice, R.W., Phelps Dodge Corporation. February 15, 1984. Section 114 request for information.
IV-C-418	Letter and enclosures from Farmer, J.R., U.S. Environmental Protection Agency, to Varner, M.O., ASARCO, Inc. February 15, 1984. Section 114 request for information.
IV-C-487	Letter from Curtis, F., U.S. Environmental Protection Agency, to Robbins, D., ASARCO, Inc. June 4, 1984. Information required for alternative method evaluation.
IV-D-119	Letter from Doniger, D.D., Natural Resources Defense Council, to Ruckelshaus, W.D., U.S. Environmental Protection Agency. July 29, 1983. Request for postponement of public hearings.
IV-D-785	Letter from Rice, R.W., Phelps Dodge Corporation, to Farmer, J.R., U.S. Environmental Protection Agency. March 2, 1984. Response to Section 114 request for information.

Item Number in Docket A-80-40	
IV-D-788	Letter and enclosures from Malone, R.A., Kennecott Minerals Company, to Farmer, J.R., U.S. Environmental Protection Agency. March 6, 1984. Response to Section 114 request for information.
IV-D-789	Letter and attachments from Varner, M.O., ASARCO, Inc., to Farmer, J.R., U.S. Environmental Protection Agency. March 15, 1984. Response to Section 114 request for information.
IV-D-790	Letter and attachments from Rice, R.W., Phelps Dodge Corporation, to Farmer, J.R., U.S. Environmental Protection Agency. March 16, 1984. Response to Section 114 request for itemization of company cost estimates.
IV-D-802	Letter and enclosures from Lindquist, L.W., ASARCO, Inc., to Ajax, R., U.S. Environmental Protection Agency. June 27, 1984. Notification of ASARCO's intention to terminate copper smelting operations at Tacoma smelter.
IV-E-23	Memorandum from Meyer, J., Pacific Environmental Services, Inc., to meeting attendees at December 20, 1983, meeting with interested parties on proposed NESHAP. December 23, 1983. Handouts containing modeling results and suggestions for emission control at ASARCO-Tacoma.
IV-E-65	Telecon. McAdams, T., Pacific Environmental Services, Inc., with Bump, B., Research-Cottrell. April 26, 1984. Cost estimate for ESP control system.
IV-E-72	Telecon. Wright, M., United Steelworkers of America, with Meyer, J., Pacific Environmental Services, Inc. April 23, 1984. Operating practices with converter ladle at ASARCO-Tacoma.
IV-E-79	Telecon. McAdams, T., Pacific Environmental Services, Inc., with Montgomery, L., Texas Air Control Board. November 26, 1984. Operation of the ASARCO-El Paso building evacuation system.
IV-E-80	Telecon. McAdams, T., Pacific Environmental Services, Inc., with Sieverson, J., ASARCO, Inc. November 28, 1984. Operation of the converter building evacuation system at ASARCO-El Paso.

Item Number in Docket A-80-40	
IV-E-81	Telecon. Robbins, D. and J. Richardson, ASARCO, Inc., with McAdams, T., Pacific Environmental Services, Inc. November 28, 1984. ASARCO's experience with corrosion on pollution control equipment at Tacoma smelter.
IV-E-82	Telecon. McAdams, T., Pacific Environmental Services, Inc., with Robbins, D.A., ASARCO, Inc. December 13, 1984. Control options regarding the ASARCO-El Paso building evacuation system.
IV-I-1	National Emission Standards for Hazardous Air Pollutants; Proposed Standards for Inorganic Arsenic, 40 CFR Part 61. Amended notice of public hearing and extension of public comment period. U.S. Environmental Protection Agency. 48 FR 38009. August 22, 1983.
IV-I-3	National Emission Standards for Hazardous Air Pollutants; Proposed Standards for Inorganic Arsenic, 40 CFR Part 61. Reopening of public comment period. U.S. Environmental Protection Agency. 48 FR 55880. December 16, 1983.
IV-I-4	National Emission Standards for Hazardous Air Pollutants; Proposed Standards for Inorganic Arsenic, 40 CFR Part 61. Reopening of public comment period. U.S. Environmental Protection Agency. 49 FR 36877. September 20, 1984.
IV-J-59	Compilation of Opacity Monitor Performance Audit Results. Prepared by Entropy Environmentalists for U.S. EPA, Washington, D.C., Document No. EPA-340/1-83-011. (January 1983).

PART II - NATIONAL EMISSION STANDARD FOR INORGANIC ARSENIC EMISSIONS FROM ARSENIC TRIOXIDE AND METALLIC ARSENIC PRODUCTION FACILITIES

II-1.0 SUMMARY

On July 20, 1983, EPA proposed a standard in the Federal Register for primary copper smelters processing feed materials with 0.7 percent or greater arsenic. The proposed standards would have affected only the ASARCO smelter in Tacoma, Washington. In the notice of proposed rulemaking, EPA stated that further evaluation of controls to reduce inorganic arsenic emissions would be conducted at ASARCO-Tacoma. The EPA conducted extensive inspections of the smelter and on December 16, 1983, proposed for comment additional control measures that could be applied to reduce fugitive arsenic emissions from the smelter and the associated arsenic plant. Over 650 comment letters were received by EPA, and many interested parties testified at the public hearings held in Tacoma, Washington, and Washington, D.C.

On June 27, 1984, ASARCO announced that it planned to close its primary copper smelting operations at Tacoma, Washington, by June 30, 1985 (the smelter closed in March 1985) (IV-D-802). In the same announcement, ASARCO stated that it will continue to operate the arsenic trioxide and metallic arsenic production plants at the site and that the plants will be operated in an environmentally acceptable manner. From discussions with ASARCO personnel, EPA has found that there is some uncertainty regarding the process to be used and the future configuration of the arsenic trioxide plant. It appears that ASARCO is considering several different modifications to its arsenic trioxide production process, including the use of a wet leaching process or enclosure of the Godfrey roasters and control of emissions using a fabric filter collector. ASARCO expects that these modifications will significantly reduce arsenic emissions from the facility but, as of this writing, has not indicated when the changes would be implemented. Consequently, EPA decided that the proposed fugitive emission control measures for the arsenic plant should be finalized at this time on the basis of current information.

Responses to comments on proposed fugitive emission control measures for the arsenic plant and issues pertaining to the continued operation of the arsenic plant are presented in this section. These comments are also addressed in the Federal Register notice of final rulemaking.

II-1.1 SUMMARY OF CHANGES SINCE PROPOSAL

A number of changes have been made to the arsenic plant requirements proposed at 48 FR 55880 on December 16, 1983 (IV-I-3). These requirements were modified as a result of public comments and planned changes in the operations of the only affected facility (ASARCO-Tacoma). These changes are: (1) deletion of specific equipment requirements for the arsenic plant. The proposed requirements for modifications to equipment in the arsenic plant have been removed from the standard. These modifications are not being required because either the equipment is in place and likely to remain in place or there is a more cost-effective means of achieving the emission reduction; (2) modification of the proposed work practices. While the proposed requirement for preparation of an inspection, maintenance, and housekeeping plan has been retained, specific aspects have been modified. The final requirements for an approvable plan do not require the inspector to follow a prescribed inspection route. In addition, the proposed requirement to shut down malfunctioning equipment until it is repaired has been modified to require the source to describe the time and actions required to curtail increased emissions due to malfunctions; and (3) clarification of the provisions for recordkeeping and reporting and inclusion of minor new provisions. The standard requires quarterly reporting of occurrences of excess opacity readings, ambient arsenic monitoring data and semiannual status reports on pilot plant studies on alternative arsenic trioxide production processes.

II-1.2 SUMMARY OF ENVIRONMENTAL, HEALTH, ENERGY, AND ECONOMIC IMPACTS

The standard being established today affects new and existing arsenic trioxide and metallic arsenic production facilities. EPA projects that the standard will affect one facility, the arsenic plant at ASARCO-Tacoma.

The standard is expected to reduce emissions due to malfunctions and upsets in the arsenic plant and to reduce reentrainment of arsenic-containing materials from plant surfaces. However, the impact of the standard on fugitive emissions from the arsenic plant is difficult to quantify because of the difficulties inherent in estimating fugitive emissions, the unpredictability of malfunctions, and the considerable uncertainties regarding the processes and operations that will be used at the facility in the future. The standard is based on application of control measures that are necessary and practicable at this time, and not on the application of a risk management approach.

Application of the required housekeeping and maintenance provisions should have no appreciable solid waste, water, or energy impacts on the facility. The annualized cost required to comply with the standard is estimated at about $265,000 per year. The primary economic impacts associated with the standard are projected small decreases in profitability for the ASARCO-Tacoma arsenic plant, if costs cannot be passed through. If costs are passed forward in the form of a price increase, it is estimated that the standard would result in less than a 5 percent increase in the price of arsenic trioxide. The ASARCO-Tacoma facility will not be forced to close as a result of the final regulation.

II-2.0 SUMMARY OF PUBLIC COMMENTS ON THE PROPOSED STANDARD

II-2.1 ARSENIC EMISSION ESTIMATES

Comments were received by EPA throughout the public comment period concerning the Agency's proposal estimates of arsenic emissions from the ASARCO-Tacoma smelter. Initially, the comments addressed the emission estimates EPA presented in the Federal Register notice of proposed rulemaking (48 FR 33125) and the BID for the proposed high-arsenic copper smelter standard (EPA 450/3-83-009a). Several commenters, including ASARCO, felt that the emission rates used in EPA's analysis significantly overstated the amount of arsenic being emitted from the Tacoma smelter. Other commenters expressed the opinion that EPA's emission estimates did not account for various low-level or intermittent sources at the smelter.

During the public comment period, the Agency released to the public a series of revised emission estimates (refer to docket references IV-B-10, IV-C-120, and IV-E-23). In these revised estimates, EPA expanded the list of sources at the smelter for which arsenic emissions were estimated. Additional comments were received on these revised estimates. The major focus of these comments was on the emission estimates for low-level sources. Upon reviewing these comments, evaluating the supporting information provided by the commenters, and obtaining additional information, EPA developed a completely new set of estimates for arsenic emissions from the entire smelter.

However, due to ASARCO's closing of the Tacoma copper smelter and the continuation of the operation of the arsenic plant, the Agency is including in this document only the comments and responses that deal directly with arsenic emissions from the arsenic plant. Since the final configuration of the arsenic plant after this change is unknown as this document is being prepared, the estimates of emissions from this facility are not considered final and might be changed. The basis for the revised emission estimates for the arsenic plant is presented in Appendix G. Appendix H contains a summary of results of the recent EPA testing performed on the arsenic plant baghouse.

II-2.1.1 Arsenic Plant Process Emissions

Comment: Several commenters, including ASARCO, stated that the emission estimates EPA presented in the Federal Register notice of proposed rulemaking (48 FR 33125) overstated the amount of arsenic emitted from the ASARCO-Tacoma smelter (IV-F-3, IV-D-22, IV-D-254, IV-D-263, IV-D-264, IV-D-326, IV-D-331, IV-D-332, IV-D-540, IV-D-600). The commenters claimed that, based on data obtained by ASARCO from continuous particulate samplers located in various flues vented to the main stack, EPA overestimated the total main stack arsenic emissions by a factor of 1.4 to 3.5. ASARCO claimed that EPA's estimates of stack emissions overstate actual emissions from the smelter because EPA's estimates were derived from: (1) an inaccurate arsenic material balance that was based on inaccurate analytical results, and (2) a 1978 material balance that did not reflect current emission controls or the effect of curtailments under the supplementary control system (SCS) program currently being implemented at the smelter to control sulfur oxide emissions.

Response: The EPA's main stack emission estimate presented at proposal was based on the best information available to EPA at the time the proposed standard was under development. The arsenic material balance used by EPA to derive emission estimates was based on a material balance developed by ASARCO that represented operations at the Tacoma smelter for the entire year of 1982 (II-D-42). The smelter SCS program was in operation throughout 1982. Thus, the values of arsenic input to the various control devices used by EPA do account for the effects of curtailments under the smelter SCS program. ASARCO's understanding that the EPA emission estimate was based on a material balance for the year 1978 is incorrect.

At the time the proposed standard was being developed, the roaster baghouse was the only control device at the ASARCO-Tacoma smelter for which test data were available to determine arsenic collection efficiency. For the other control devices, the arsenic collection efficiency was estimated on the basis of test data for similar control devices currently used at the ASARCO-El Paso smelter or previously used at the Tacoma smelter (these estimates are described in docket reference IV-B-6). Using this approach, EPA estimated the main stack arsenic emission value presented in the Federal Register notice of proposed rulemaking. This estimate showed that of the total main stack arsenic emissions, 55 percent is contributed by the reverberatory smelting furnace and 42 percent by the arsenic plant. Since over 97 percent of the main stack arsenic emissions was estimated to be contributed by two sources based on estimated arsenic collection efficiencies, and in response to comments EPA received concerning these estimates, EPA decided to perform additional emission tests at the ASARCO-Tacoma smelter to obtain more data on the main stack emissions.

The results of this test program carried out in September 1983, are presented in Appendix H (as the results relate to the baghouse controlling emissions from the arsenic plant). Based on this testing, the arsenic plant baghouse emits 0.33 pound per hour (0.15 kg/h) of inorganic arsenic. At the time of the emission tests, baghouse emissions were ducted to the main stack, together with emissions from several other control devices at the smelter. This revised emission value based on recent testing is only about 2 percent of the value of 16 lb/h (7.3 kg/h) that EPA used at proposal in its estimation of total main stack emissions.

II-2.1.2 Low-Level Emissions From the Arsenic Plant

Comment: The United Steelworkers of America (USWA) commented that EPA's proposal estimates of low-level arsenic emissions do not include all the low-level emission sources observed at the Tacoma smelter by Union representatives (IV-F-8). ASARCO stated that EPA's estimates for many of the low-level sources were overstated at proposal because control measures implemented by ASARCO as of December 1983, have reduced emissions below the levels estimated by EPA (IV-D-621). The Washington

State DOE expressed an opinion that low-level fugitive emissions are a major cause of the high 24-hour ambient arsenic concentrations that have been recorded near the smelter. (Maintenance and material handling at the arsenic plant were cited as activities that contribute to these emissions.) This commenter recommended that these emissions be identified and controlled (IV-D-622).

Response: Since proposal of the standard, new information about the sources of low-level arsenic emissions at the ASARCO-Tacoma smelter was obtained by EPA during extensive visits to the smelter. On June 21, 22, and 23, 1983, a comprehensive inspection of the ASARCO-Tacoma smelter was conducted by EPA to identify potential sources of low-level emissions and to document the types of control measures or practices applied. From September 12 to 29, 1983, EPA conducted emission source testing of the ASARCO-Tacoma No. 1 Cottrell and the arsenic plant baghouse. During these periods, EPA monitored the smelter processes and, consequently, had the opportunity to observe on a daily basis the process operations, control equipment performance, and worker operating and housekeeping practices at the smelter. Based on these observations and an improved understanding of operations at the Tacoma smelter, EPA revised its emission rate estimates for low-level sources. In October 1983, EPA placed in the docket for public comment (IV-B-10) a revised and expanded set of low-level arsenic emission rate estimates for sources other than the converters at the smelter. These estimates were based on controls in place on the sources during 1982.

Since 1982, additional control measures have been implemented by ASARCO to reduce arsenic emissions from the ASARCO-Tacoma smelter. The U.S. Occupational Safety and Health Administration (OSHA) standards for occupational exposure to inorganic arsenic (II-J-10) required ASARCO to implement the following actions at the smelter: (1) by December 1, 1978, respirators to be worn by workers exposed to arsenic concentrations over 10 $\mu g/m^3$; (2) by July 1, 1979, completion of "clean" lunchroom and hygiene facilities; and (3) by December 31, 1979, completion of engineering controls. Actual implementation of some of the requirements of the OSHA arsenic standard was delayed by litigation of the standard. On December 6, 1982, a plan for achieving compliance with the OSHA arsenic standard was agreed upon by ASARCO, the State of Washington Department of Labor and Industries, and the Union representing the Tacoma smelter workers (USWA). This agreement, referred to as the "Tripartite Agreement," is in effect through July 1, 1987, and requires that ASARCO implement at the Tacoma smelter additional engineering controls during 1983 and 1984 (IV-D-447). Also, since 1982, ASARCO has voluntarily installed new equipment at the ASARCO-Tacoma smelter to control arsenic emissions (e.g., in 1983, ASARCO installed a pneumatic conveyor system to transfer the arsenic plant Godfrey roaster calcines directly to the Herreshoff roasters).

While it is unclear as to how ASARCO's closing of the copper smelter will affect arsenic emissions from the arsenic plant, the revised low-level emission estimates for the arsenic plant developed since proposal are presented in Appendix G. Emission estimates are presented for two control situations: assuming the controls in place as of December 31, 1982, and assuming the additional control measures implemented by ASARCO since that date. The latter control situation includes the addition of the control measures called for in this NESHAP.

The Administrator agrees with the commenter that fugitive emissions (as well as process emissions vented to the baghouse) from the arsenic plant at ASARCO-Tacoma should be controlled. The final regulation for the arsenic plant contains requirements in the form of equipment and work practice standards, selected from among those discussed in the December 16, 1983, Federal Register notice of proposal, 48 FR 55880 (IV-I-3), after consideration of public comments on the need, feasibility, and costs of the requirements. The requirements are expressed in the form of equipment, work practice, and operational standards because these emissions cannot be accurately measured.

II-2.2 COMMENTS ON PROPOSED CONTROL TECHNOLOGY

Comment: ASARCO and the USWA commented on the proposed controls for fugitive emissions from the arsenic plant (IV-D-703, IV-D-708a). ASARCO felt that the listed control measures were developed without consideration of the likelihood of the material being emitted into the ambient air, their technical feasibility or cost, or the cost effectiveness of the measures in reducing any health risk. Both commenters expressed opinions on the proposed requirement for a dust-tight conveying system for arsenic plant materials. ASARCO felt that: (1) it is not possible to use an enclosed pneumatic conveying system to transfer wet dust (the dust is wetted because the Godfrey roasters cannot accept dry dust); and (2) the present covered belt conveyor system is best available technology. The USWA also commented that pneumatic conveying would require relocation of the zig-zag blender, and recommended as an alternative that ASARCO be required to maintain the fullest possible enclosure of the zig-zag blender and belt transfer system and to ensure that leaks are promptly identified and repaired. In response to the proposal to require installation and maintenance of a solid refractory arch on each Godfrey roaster, both ASARCO and USWA commented that all the arches have now been installed.

Response: The proposed additional control measures were based on EPA's assessment of controls that could be used to reduce fugitive emissions from the arsenic plant. The likelihood of fugitive emissions being released to the atmosphere was considered by EPA in developing the requirements. The generally open configuration of the buildings and EPA observations indicate that emissions released inside the structures housing the arsenic plant are likely to be released to the atmosphere. In some cases, such emissions disperse directly to the air outside the buildings. In other cases, the emissions may settle on supporting structures and surfaces within the buildings. These deposits of dust in and around buildings and plant surfaces can be re-entrained during periods of high winds. In fact, ASARCO has attributed some episodes of high ambient arsenic concentrations to re-entrainment of dust from plant and building surfaces. Similarly, EPA also believes that spills of materials can serve as sources of fugitive emissions through re-entrainment of dust from building and plant surfaces. The final requirements address all fugitive emission sources at the arsenic plant operation as these sources are understood at this time. In developing these control measures, EPA also developed estimates of the costs and potential emission reduction. These control measures and emission reduction estimates were briefly discussed in the meeting held December 20, 1983 (IV-E-77), and were placed in the docket for public inspection (IV-E-23). [In response to comments, these estimates were revised and the revised estimates were also distributed to the meeting attendees for comment and to the public docket (IV-C-458).] As discussed in Section II-1.2, an accurate estimate of the emission reduction resulting from control measures applied to the arsenic plant cannot be made at this time. Nonetheless, EPA believes that the final control requirements, including best fugitive emission controls, are necessary for this facility. The Agency estimates that the annualized cost to maintain these controls will be about $265,000 per year. These control measures were selected based on consideration of the emission reduction that would be obtained, the technical feasibility, and the estimated costs.

The EPA considered the comments on the proposed dust-tight conveyor and believes that a pneumatic conveyor could be used as proposed by relocating the zig-zag blender closer to the Godfrey roasters. However, a more cost-effective approach to this control objective would be through improved housekeeping and maintenance of the existing system, as recommended by the USWA. Since EPA is establishing provisions for a routine maintenance and repair program in this NESHAP, the proposed requirement for a dust-tight conveyor system in the arsenic plant is not included in the final regulation.

The final standard does not include a requirement for refractory arches over the Godfrey roasters, since EPA judges that these controls are in place and likely to remain in place.

II-2.3 OPERATION AND MAINTENANCE REQUIREMENTS

Comment: The Washington State Department of Ecology (DOE) recommended that the final regulation include provisions requiring inspection and maintenance of the equipment used for control of arsenic emissions throughout the ASARCO-Tacoma smelter (not just of the converter secondary hood system, as proposed) (IV-D-622).

ASARCO and USWA commented on EPA's five general objectives, proposed in the December 16, 1983, Federal Register notice, for an inspection, maintenance, and housekeeping plan for the Tacoma smelter (IV-D-703, IV-D-767). This plan consisted of the following points:

1. "No accumulation of material having an arsenic content greater than 2 percent on any surface within the plant outside of a dust-tight enclosure."

ASARCO's comments on this objective of the management plan were: (1) This requirement can only be interpreted as meaning the entire plant would have to be placed within an enclosure, and (2) the costs of such an enclosure would be astronomical. The USWA commented that dry, dusty materials with arsenic concentrations well below 2 percent may contribute significantly to fugitive emissions from the plant, while damp materials with higher arsenic content would not contribute significantly. In other words, the moisture content is as important a consideration as the arsenic content.

2. "Immediate cleanup of any spilled material having an arsenic content greater than 2 percent."

ASARCO's comments on this objective were: (1) There is a housekeeping program in place as part of the OSHA/WISHA arsenic compliance requirements, (2) any clean-up requirements should be directed toward specific sources and materials and should be handled by a regulatory agency compliance requirement, and (3) the objective does not consider whether the material is likely to become airborne. The USWA comments on this proposed requirement were the same as their comments on the preceding requirement.

3. "Regular scheduled maintenance of all smelter process, conveying, and emission control equipment to minimize equipment malfunctions."

Both ASARCO and USWA commented that this proposed objective is currently required by the Tripartite Agreement, and USWA further commented that it should also be included in the final standard.

4. "Regular inspection to ensure equipment is operating properly."

ASARCO commented that there is an inspection procedure in place, and it is unreasonable to require the proposed inspection routine and documentation. In contrast, the USWA agreed with the proposed objective and recommended that the inspector document general housekeeping in each area to ensure plant surfaces are kept free of dry, dusty materials. Both ASARCO and USWA commented that it is unnecessary to require the inspector to follow a prescribed route.

5. "Repair of malfunctioning or damaged equipment."

ASARCO commented that they oppose the proposed requirements because the urgency of the repair is not related to the quantity of emissions to the air or impact on air quality. They also considered the proposal to be unreasonable because it removed from ASARCO the discretion and authority to determine and take appropriate action. The USWA commented that it is not always practicable or necessary to shut down operations involving material with more than 2 percent arsenic.

Response: The rationale for requiring no accumulation of arsenic-containing materials and clean-up of spills, as previously discussed, is that re-entrainment of part or all of the material is possible and re-entrained material is likely to enter the atmosphere. The intent of the proposed requirement was not, as suggested by ASARCO, to require enclosure of the entire plant, which obviously is not practicable. Instead, the intent was to focus attention on control of potentially significant sources of fugitive arsenic emissions from sources such as arsenic kitchen pulling or handling of baghouse dust and to exclude non-arsenic bearing materials. The EPA considers the USWA's comment that the requirement should be limited to dry, dusty materials to be valid. Consequently, this objective has been reworded in the final work practices standard [§61.182(b)(1)(i)] to require cleaning up, wetting, or chemical stabilization of accumulations of dry, dusty materials with appreciable arsenic content (greater than 2 percent). The objective has not been revised as suggested by USWA to include materials with more than 0.2 percent arsenic because limiting the requirement to materials with more than 2 percent arsenic essentially requires clean-up or control of all sources in the arsenic plant.

The EPA reviewed ASARCO's housekeeping plan submitted to WISHA and found that its scope was much narrower than intended by the Agency's proposal. Thus, at present ASARCO's existing housekeeping program cannot be considered an adequate substitute for the proposed objective. The EPA believes that the second objective of the general work practice plan should be included in the final standard to ensure that prompt attention is given to clean-up or control of spilled materials containing greater than 2 percent arsenic. It is not practicable at this time to identify in the regulation every potential source of spills because the exact configuration and full extent of the arsenic plant operations have not yet been established. EPA believes that, unless this requirement is part of the regulation, there will be no means of ensuring the attendant emission control. Therefore, the requirement has been included in the final regulation [§61.182(b)(1)(ii)].

The third provision (regular scheduled maintenance) is included in the final standard to establish more explicit requirements than does the Tripartite Agreement. Regular maintenance items are not specified in the regulation, but will be included in the inspection, maintenance, and housekeeping plan submitted by the owner or operator under the final regulation. In the course of regular inspections (see below), most maintenance needs will be identified and attended to on an as-needed basis. Examples include identification and replacement of defective fabric filter bags, and repair of leaks in dust conveying equipment.

The EPA believes that the proposed regular inspection objective (provision no. 4) is a necessary element of the management plan to minimize fugitive and excess emissions, and thus is included in the final standard [§61.182(b)(2)]. The proposed requirement for a prescribed route, however, is deleted as it is unnecessary as long as all equipment and areas are inspected. The regular inspection of equipment will ensure that impending or actual malfunctions are detected before preventable emissions occur. The required checklist will create a record that can be used to determine possible causes of higher than normal ambient arsenic concentrations near the plant. The EPA believes that regular inspection and documentation is necessary because ASARCO's correspondence with PSAPCA and EPA suggests that equipment malfunctions and upsets and other causes of higher than normal emissions presently are not systematically documented. Further, during the public hearing in Tacoma, ASARCO representatives confirmed that they do not have procedures that document all observed emissions and their causes. The EPA believes that such documentation is necessary to objectively pursue an effective emission control program. As suggested by the USWA, the inspection procedure has been expanded to include observation and documentation of housekeeping practices. This inspection procedure and its required documentation will increase awareness of and emphasis on emission control.

The EPA considered the comments on the fifth provision and consequently revised the proposed objective to require the company to submit a plan, subject to the approval of the Administrator, describing the actions that will be taken to curtail operations when process upsets or malfunctions of process, emission control, or material handling equipment occur that could result in increased emissions of arsenic [§61.182(b)(5)]. This plan will describe the time required and the procedures to be used to curtail increased emissions due to malfunctions. The plan will also describe any technical limitations on curtailments. This approach will allow sufficient flexibility to consider technical limitations and to consider whether specific individual malfunctions would increase emissions of inorganic arsenic to the atmosphere.

II-2.4 REPORTING AND RECORDKEEPING

Comment: The Washington State DOE recommended that a requirement be added to the regulation for the reporting of any upset, breakdown, or related problem with equipment that would result or might result in increased emissions of arsenic. This commenter also suggested that a log of material handling, repair and maintenance operations, or other operations that could result in increased arsenic emissions be kept at the smelter. (Comments were made with regard to the ASARCO-Tacoma smelter.) (IV-D-622)

Response: As the previous response indicates, the owner or operator of each affected arsenic production plant is required to submit to the Administrator a list of potential sources of inorganic arsenic emissions and a plan describing the actions that would be taken to identify malfunctions and curtail operations after a malfunction had occurred. The plan to minimize fugitive emissions also includes provision for the maintenance of records of regular inspections of process, conveying, and control equipment.

The EPA believes that the plan to document the inspection, maintenance, and housekeeping status of the equipment at arsenic plants addresses the concerns shown by the commenter. The plan focuses on prevention of malfunctions and on curtailment of operations until a malfunction is corrected. It further requires removal of accumulations and clean-up of spills of arsenic-containing materials. These are considered the best steps that can be taken to minimize fugitive arsenic emissions from arsenic plants to the maximum extent practicable.

II-2.5 NEED FOR AN AMBIENT STANDARD

Comment: A number of commenters, including ASARCO, local governmental agencies (PSAPCA and Washington State DOE), and environmental and union groups (NRDC and USWA), commented on the need for an ambient arsenic concentration limit in the vicinity of the ASARCO-Tacoma smelter.

(These comments and the Agency's response are still considered to be applicable because ASARCO intends to continue operation of the arsenic plant at Tacoma.)

It was suggested by one commenter that the final standard should specify the monitoring and analytical techniques to be used in measuring ambient levels. PSAPCA specifically recommended that EPA establish 24-hour and annual average arsenic action levels to enforce implementation of a fugitive emission control program at the ASARCO-Tacoma facility (IV-D-693, IV-F-3).

Other commenters felt that EPA should not establish an ambient standard for arsenic. The Washington DOE said that while it intends to establish 24-hour and annual average community exposure standards to limit arsenic emissions, it did not recommend that EPA adopt an ambient, or community exposure, standard. The DOE believes there is a need for flexibility in implementing such a standard for the area around the ASARCO-Tacoma smelter. Hence, in April 1984, the DOE adopted interim ambient standards and plans to adopt permanent standards after evaluation and study of the causes of high ambient arsenic concentrations in the Tacoma area. The interim standards limit maximum 24-hour ambient concentrations of arsenic to 2.0 $\mu g/m^3$ and maximum annual average ambient concentrations of arsenic to 0.3 $\mu g/m^3$ (IV-D-622).

The USWA and NRDC commented that an ambient standard for carcinogens is inappropriate and not authorized under the Act (IV-D-708a, IV-D-710). These commenters argued that an ambient standard is inappropriate because no safe level can be established for zero-threshold pollutants. They do believe, however, that an ambient monitoring requirement and an "action level" used as an adjunct to enforcement would be useful and authorized under the Act. The USWA specifically recommended: (1) that the action level should be achievable when all controls are working properly and should be revised periodically, and (2) that exceedances of the action level should trigger an investigation by the company and a report to EPA. The USWA also recommended that the ambient monitoring requirement include provisions requiring ASARCO to study and estimate regularly the fugitive emissions from all sources in the plant, and to prepare and implement a management plan for control of fugitive emissions.

ASARCO commented on the legal authority and recommendations for an ambient arsenic standard or community exposure level. The company believes that the language and legislative history of the Clean Air Act show that Section 112 does not empower EPA to set an enforceable ambient standard. ASARCO maintained that the clear thrust of Section 112 is that EPA is responsible for adopting standards that limit continuously the amount of emissions of hazardous air pollutants from individual sources. ASARCO argued that an ambient standard would not be useful or appropriate because: (1) ambient arsenic concentrations are presently monitored and will continue to be monitored; (2) ambient concentrations around a source vary due to factors other than emission rates, including meteorological conditions and local terrain; (3) fugitive emissions are already well controlled; and (4) there are no medical criteria that can be used to establish the concentration level and averaging period of such a standard. A further argument against an ambient standard presented by ASARCO was that an ambient standard would not be an effective means of reducing arsenic emissions. ASARCO commented that an ambient standard would have to be achieved by either emission controls or production curtailments and that EPA would have to identify sources of emissions causing high ambient arsenic levels and determine the controls required to attain the standard. ASARCO pointed out that, in the case of a 24-hour standard, it would be difficult to determine what controls should be required because it is not possible to determine retroactively the causes of high arsenic values. It was also argued that maintaining an ambient arsenic standard by intermittent production curtailment was not feasible. Curtailment is not considered a feasible approach to arsenic control because: (1) there is currently no real-time monitoring system for arsenic; (2) it is not practicable because of lack of knowledge about which sources should be curtailed; and (3) arsenic emission sources require lengthy shutdown periods before they cease emitting arsenic (IV-D-621).

Response: Since an enforceable ambient standard is not being established in the final standard, ASARCO's comment (that Section 112 of the Clean Air Act does not give EPA the authority to set enforceable ambient standards) is not pertinent to this rulemaking. The EPA agrees that an ambient standard cannot be established for inorganic arsenic based solely on health effects or risk estimates. The Agency does believe, however, that an enforceable ambient limit, which is an indicator of proper operation and maintenance of emission control systems and is developed considering all relevant factors, is consistent with Section 112 and may consider establishing a limit at a later date. Such a limit would serve as a direct measure of the degree to which fugitive arsenic emission sources at the arsenic plants were being controlled. The EPA intends to review ambient arsenic monitoring data in the future to determine if additional control measures are needed, and the standard requires quarterly reporting of ambient monitoring data to facilitate this review. Among the measures that would be considered is an enforceable boundary limit, provided that sufficient information and data are available to establish a limit. The enforceable boundary limit would be used to evaluate the effectiveness of required control measures and would not impose any additional control requirements. Similarly, production curtailments would not be required in order for compliance with the limit to be achieved. Hence, ASARCO's comments regarding the utility of an ambient standard are not applicable to the concept of an enforceable boundary limit.

Depending on the steps ASARCO takes to reduce emissions in future operations of the arsenic plant, EPA plans to establish the need for additional control measures and the need for an enforceable boundary limit after the effects of the required control actions are assessed. This assessment will involve a comparison of ambient levels of arsenic measured near the arsenic plant with ASARCO's records of operation for the arsenic plant. The Agency believes that this information will help to identify operational practices that cause high ambient concentrations, and the degree to which additional controls might reduce ambient arsenic concentration levels. In particular, exceedances of the DOE standard would be investigated to determine the cause and to suggest possible control measures. The review may also consider the need for requiring periodic review of emissions and control measures to ensure the continued effectiveness of the housekeeping plan.

II-3.0 REFERENCES*

Item Number in Docket A-80-40	
II-D-42	Letter and attachments from Varner, M.O., ASARCO, Inc., to Farmer, J.R., U.S. Environmental Protection Agency. March 16, 1983. Response to Section 114 request for information.
II-J-10	Occupational Exposure to Inorganic Arsenic; Final Standard, Chapter XVII, 29 CFR Part 1910. Occupational Safety and Health Administration. 43 FR 19584. May 5, 1978.
III-B-1	Inorganic Arsenic Emissions from High-Arsenic Primary Copper Smelters - Background Information for Proposed Standards (Draft EIS). U.S. Environmental Protection Agency. Research Triangle Park, N.C. Document No. EPA-450/3-83-009a. April 1983.
IV-A-6	Emission Test Report, Arsenic Sampler Comparison, ASARCO, Inc., Tacoma, Washington. Prepared by PEDCo Environmental, Inc., for U.S. EPA, Research Triangle Park, N.C. EMB No. 83-CUS-20. January 1984.
IV-B-6	Letter from Vervaert, A.E., U.S. Environmental Protection Agency, to Zimmer, C., PEDCo Environmental, Inc. August 25, 1983. Transmittal of main stack arsenic emission estimates for ASARCO-Tacoma.
IV-B-10	Letter and enclosures from Vervaert, A.E., U.S. Environmental Protection Agency, to Schewe, G.F., PEDCo Environmental, Inc. October 28, 1983. Technical background on low-level arsenic emission estimates for ASARCO-Tacoma.
IV-C-120	U.S. Environmental Protection Agency, Region X. News release to the public regarding new data on arsenic emissions from ASARCO-Tacoma. October 20, 1983.
IV-C-458	Letter and enclosures from Ajax, R.L., U.S. Environmental Protection Agency, to Newlands, J.C., Eisenhower, Carlson, Newlands, Reha, Henriot, and Quinn. March 9, 1984. Transmittal to eight addressees of several items related to development of standard for ASARCO-Tacoma.

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*Lists references cited in Section II, including appendices. Appendix A contains a listing of public comment letters on the proposed standards.

Item Number in Docket A-80-40	
IV-D-447	Letter and enclosures from Cant, S.M., Washington State Department of Labor and Industries, to Whaley, G., Pacific Environmental Services, Inc. October 5, 1983. Transmittal of copies of the Tripartite Agreement for ASARCO-Tacoma.
IV-D-802	Letter and enclosures from Lindquist, L.W., ASARCO, Inc., to Ajax, R., U.S. Environmental Protection Agency. June 27, 1984. Notification of ASARCO's intention to terminate copper smelting operations at Tacoma smelter.
IV-E-23	Memorandum from Meyer, J., Pacific Environmental Services, Inc., to meeting attendees at December 20, 1983 meeting with interested parties on proposed NESHAP. December 23, 1983. Handouts containing modeling results and suggestions for emission control at ASARCO-Tacoma.
IV-E-77	Memorandum from Meyer, J., Pacific Environmental Services, Inc., to Chaput, L., U.S. Environmental Protection Agency. January 20, 1984. Minutes of meeting to discuss modeling results and emission control alternatives for ASARCO-Tacoma with interested parties.
IV-I-3	National Emission Standards for Hazardous Air Pollutants; Proposed Standards for Inorganic Arsenic, 40 CFR Part 61. Reopening of public comment period. U.S. Environmental Protection Agency. 48 FR 55880. December 16, 1983.

PART III - APPENDICES

APPENDIX A

LIST OF COMMENTERS ON PROPOSED STANDARDS FOR HIGH- AND LOW- ARSENIC PRIMARY COPPER SMELTERS

LIST OF COMMENTERS ON PROPOSED STANDARDS[a]

Docket Item Number*	Commenter and Affiliation[b]
IV-D-1; IV-D-95; IV-D-677; IV-F-10	Susan and Robert Adams
IV-D-2; IV-D-37; IV-D-90	Ms. Teresa Doyle
IV-D-3	Mr. Hugh Kimball
IV-D-4	Ms. Susan Anderson
IV-D-5; IV-D-93; IV-D-530; IV-D-673	Ms. Sheri Reder
IV-D-6	Mr. Eugene Fujimoto
IV-D-7	Ms. Marilyn Muller
IV-D-8	Mr. Craig D. Hilborn
IV-D-9; IV-F-9	Mr. John T. Konecki
IV-D-10	Chris Connery and Mary Scott
IV-D-11; IV-D-127; IV-D-677	Dr. Robert E. Sullivan
IV-D-12	Mr. Thomas M. Skarshaug *et al.*
IV-D-13	Ms. Virginia Nichols
IV-D-14	Mr. Philip H. Abelson
IV-D-15	Ms. Nathallie Fitzgerald
IV-D-16	Mr. James J. Mason
IV-D-17	Mr. T.C. White ASARCO, Inc.
IV-D-18; IV-D-19; IV-D-59; IV-D-64; IV-D-222; IV-D-445; IV-D-602; IV-D-603; IV-D-620; IV-D-621; IV-D-649; IV-D-691; IV-D-702; IV-D-703; IV-D-714; IV-D-716; IV-D-787; IV-D-792; IV-D-793; IV-F-2[c]	Mr. L. W. Lindquist ASARCO, Inc.

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*All items are in Docket A-80-40 unless otherwise noted.

Docket Item Number	Commenter and Affiliation[b]
IV-D-20	Mr. Duncan Berry
IV-D-21	Mr. Terry Sullivan
IV-D-22	Mr. Hans Zeisel The University of Chicago Law School
IV-D-23	Mr. Hollis Day Day's, Inc. The Warnaco Group
IV-D-24; IV-D-136	Mr. Harvey S. Poll Puget Sound Air Pollution Control Agency
IV-D-25; OAQPS-79-8/IV-D-3	George and Adriana Hess
IV-D-26	Mr. Steve Burcombe
IV-D-27	Mr. Arnold Cogan Cogan & Associates
IV-D-28	Mr. Frank M. Parker, III Southwest Occupational Health Services, Inc.
IV-D-29	Mr. John J. Sheehan United Steelworkers of America
IV-D-30; IV-D-283; IV-D-383	Mr. Edward S. Watts
IV-D-31	Mrs. Delores Keating
IV-D-32; IV-D-677	Ms. Sharon Rue
IV-D-33	Ms. Joy Nelsen
IV-D-34	"A Concerned Citizen"
IV-D-35; IV-D-593; IV-F-9	Mr. Ralph K. Garrison
IV-D-36	Ms. Barbara Jensen
IV-D-38; IV-F-10	B. J. Kanagy
IV-D-39	Ms. Elise Muller Lindgren

Docket Item Number	Commenter and Affiliation[b]
IV-D-40	Ms. Patricia Ives
IV-D-41	Ms. Rebecca L. Graves
IV-D-42	Janis and Gregory McElroy
IV-D-43; IV-D-114; IV-D-438	Fred and Sue Campbell
IV-D-44	David and Ann Beckwith Boberg
IV-D-45	Ms. Susan Konecki
IV-D-46	Vernon and Christine Trevellyan
IV-D-47	Erica and Michael Meade
IV-D-48	Mr. Richard L. Swenson
IV-D-49; IV-D-375	Ms. Elaine Taylor
IV-D-50	Mr. Paul J. Braune
IV-D-51	Ms. Hymen Diamond
IV-D-52	Ms. Nancy Sosnove
IV-D-53	Ms. Terry Patton
IV-D-54	Ms. Patricia Bauer
IV-D-55; IV-D-329; IV-D-687	Mr. E. Zahn
IV-D-56	Mr. David Burcombe
IV-D-57	Mr. Michael Higgins
IV-D-58; IV-D-253; IV-D-621; IV-D-683	Mr. Glenn L. Boggs
IV-D-60	Mr. Toby Holmes
IV-D-61	Ms. Laurie E. Martin
IV-D-62	Mr. and Mrs. Donald R. Jopp
IV-D-63; IV-D-435; IV-D-721; IV-F-11	Ms. Irene Blackford

Docket Item Number	Commenter and Affiliation[b]
IV-D-65	Ms. Ellen Ostern
IV-D-66	Mr. David Parent
IV-D-67	Mr. and Mrs. Leo A. Yuckert
IV-D-68	Ms. Mildred Schiffor
IV-D-69	Mr. R.W. Neuser
IV-D-70	Mr. Douglas P. Coleman Coland, Inc.
IV-D-71	Mr. and Mrs. Al Booze
IV-D-72	Ms. Olivia Watt
IV-D-73; IV-D-105; IV-D-302; IV-D-575	Mr. Robert Krimmel
IV-D-74	Nancy Morgan and Michael Barnes
IV-D-75	Mr. Noel Daley
IV-D-76; IV-D-117; IV-D-443; IV-D-757; IV-F-11	Mr. Frank W. Jackson Vashon-Maury Island Community Council
IV-D-77	Ms. Tammi L. Contris
IV-D-78	Ms. Frances Wotton
IV-D-79	Mr. and Mrs. Fuller
IV-D-80; IV-D-677	Ms. Caroline Hunter Davis
IV-D-81; IV-D-121	Mr. Robert Lipp
IV-D-82	Mary and Stephen Daniel
IV-D-83	Mr. Stanley C. Smith
IV-D-84; IV-D-677	Norene, Vince, and Patricia Gallo
IV-D-85	Mr. Timothy Walsh Greenpeace Northwest

Docket Item Number	Commenter and Affiliation[b]
IV-D-86	Ms. Mary Lane
IV-D-87	Mr. William Breitenbach
IV-D-88; IV-D-109; IV-D-676; IV-F-11	Ms. Diane Harris
IV-D-89	Mr. Michael Maskule
IV-D-91	Ms. Harriet Strasberg
IV-D-92	Mr. J. Brady
IV-D-94	Ms. Cheryl Owings
IV-D-96	Ms. Deborah J. Mills
IV-D-97	Mr. G. R. Finden
IV-D-98	Ms. Laura H. Vaughn
IV-D-99	Ms. Gertrude Quinn
IV-D-100	Ms. Mona Brady
IV-D-101	Ms. Rose Owens
IV-D-102	Ms. Carol Howell
IV-D-103; IV-D-111	Ms. Dana Larson
IV-D-104; IV-D-677	Ms. Dorothy J. Sivertson
IV-D-106; IV-D-677	Mr. Scott Sruly
IV-D-107	Terry Graves
IV-D-108; IV-D-589	Mr. Percy W. Lewis
IV-D-110	Ms. Pat Burke Tischler
IV-D-112	Ms. Sandra Ellis
IV-D-113	Katharine and Theodore Kowalski
IV-D-115; IV-D-429	Ms. Toni Beckman
IV-D-116; IV-D-433	Rev. Merry Kogut

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IV-D-118; IV-D-126; IV-F-11	Dr. Ruth Weiner Sierra Club, Cascade Chapter
IV-D-119; IV-D-446; IV-D-648; IV-D-710, 710a, 710b; IV-D-745; IV-D-749; IV-D-759; IV-F-2[c]; OAQPS-79-8/IV-D-33, 33a, 33b	Mr. David D. Doniger Natural Resources Defense Council, Inc.
IV-D-120; IV-D-621	Dr. Gilbert S. Omenn University of Washington School of Public Health and Community Medicine
IV-D-122; IV-D-723	Ms. Rose Orr
IV-D-123	Ms. Gail L. Warden Group Health Cooperative of Puget Sound
IV-D-124; IV-D-670	Mr. Ted Dzielak Greenpeace Northwest
IV-D-125	Mr. Phillip A.M. Hawley
IV-D-127	Robert and Petra Sullivan
IV-D-128	Mr. C.R. Myrick
IV-D-129	Ms. Dana Griffin
IV-D-130	Mrs. S.C. Sandize
IV-D-131	Ms. Kathleen Hobaugh
IV-D-132	Mrs. G.R. Byrski
IV-D-133; IV-D-485; IV-D-621	Mr. Russell I. Lewis
IV-D-134	Ms. Jenny Binder
IV-D-135	Mrs. John E. Erickson
IV-D-137	Mr. Gene Alberts Pacific Sun Ltd.
IV-D-138	George and Norma Newcomb
IV-D-139	Ms. Sue Hanson

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IV-D-140; OAQPS-79-8/IV-D-6	Mr. J.W. George Tennessee Chemical Company
IV-D-141; OAQPS-79-8/IV-D-7	Mr. David C. Roberts
IV-D-142	Mr. Del Langbauer
IV-D-143	Ms. Diane Kay Davis
IV-D-144; IV-D-719	Mr. Noel McLane
IV-D-145	Mr. Paul F. Munn City of Toledo Dept. of Public Utilities
IV-D-146	Mr. Jeffrey P. Davis
IV-D-147	Ms. Johanna H. Mason
IV-D-148; IV-D-667	Mr. Joe Geier
IV-D-149; IV-D-621; OAQPS-79-8/IV-D-2	Mr. Douglas Frost, Ph.D.
IV-D-150	Dr. Douglas A. Smith
IV-D-151; OAQPS-79-8/IV-D-10	Walter and Dorothy Pelech
IV-D-152	Ms. Leah Quesenberry
IV-D-153	Mr. Bill Stewart
IV-D-154	Mr. R.J. Kirrage National Blower & Sheet Metal Company
IV-D-155	Mr. Peter K. Schoening Chemical Proof Corporation
IV-D-156	Mr. C. W. Bledsoe Canal Industrial Supply Company
IV-D-157	Mr. Richard B. Barrueto Carl F. Miller & Company
IV-D-158	Frank and Deborah Jackson

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IV-D-159	Ms. Paula Bond
IV-D-160; IV-D-316; IV-D-453; IV-D-577; IV-D-658; IV-D-695	Mr. Robert Bloom
IV-D-161	Mr. David Hakala
IV-D-162	Mrs. Richard Tallman
IV-D-163	Mr. Thomas Jay Allen
IV-D-164; IV-D-666	Ms. Mary G.L. Shackelford
IV-D-165	Ms. Mildred E. Blandford
IV-D-166	Ms. Elsie Wood
IV-D-167	Mr. Donald E. White
IV-D-168	Ms. Claudia Hurd
IV-D-169	Ms. B.J. Hartman
IV-D-170	Mr. Ralph Brock
IV-D-171	Mr. Charles E. Hochmuth
IV-D-172	Mr. John F. Mattes
IV-D-173	Mr. Richard L. Barney
IV-D-174	Avelino and Amelita Soareuas
IV-D-175	Mr. and Mrs. George Kahl
IV-D-176	Mr. Harold T. Rock
IV-D-177	Mr. David Walkup
IV-D-178	Mr. Raymond Garner
IV-D-179; IV-D-621	Mr. Owen T. Gallagher
IV-D-180	Mr. Joe E. Bartosch
IV-D-181	Mr. Richard Balles

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IV-D-182	Mr. Al Cook
IV-D-183	Mr. Eric Zeikel
IV-D-184	Mr. Ben R. Petrie
IV-D-185	Ms. Mary LaPlant
IV-D-186; IV-D-352	Mr. Lee R. Carl
IV-D-187	Mr. Stanton Neut
IV-D-188	Mr. Stephen J. Romanovich
IV-D-189	Mr. and Mrs. Dennis F. Keating
IV-D-190	Mr. Glenn E. Enzler
IV-D-191	Mr. and Mrs. Richard Rader
IV-D-192	Mr. Maurice C. Killenbeck
IV-D-193	Mrs. L.G. Tallman
IV-D-194	Mr. Warren Mattson
IV-D-195	Mr. Marion Beach
IV-D-196	Mr. Robert L. Sprague
IV-D-197	Mr. R. Andress
IV-D-198	Clarence and Lorene Borell
IV-D-199	Mr. D.L. Bean
IV-D-200	Mr. Robert D. Hughes
IV-D-201	Mr. and Mrs. Roy Nybeck
IV-D-202	Mr. John Fuller
IV-D-203	Mr. Norman D. Bond
IV-D-204	Mrs. C.W. Koski
IV-D-205	Mr. Gerald E. Johnson

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IV-D-206	Mr. Kenneth R. Leffler
IV-D-207	Mr. Emil H. Novis
IV-D-208	Mr. Robert A. Bowman
IV-D-209	Ms. Shirley Welch
IV-D-210	Mr. and Mrs. Jay Hensley
IV-D-211	Mai Van Nguyen
IV-D-212	Mr. Harold E. Jorgenson
IV-D-213	Mr. John Bentson Vale
IV-D-214	Mr. Ron Streich Streich Bros. Engineering
IV-D-215	Mr. Arthur J. Dunaway
IV-D-216	Minnie and Al Greco
IV-D-217	Doug and Kristy Funkley
IV-D-218	Mr. Joseph Udovich
IV-D-219	Mr. Robert Zimmerman
IV-D-220	Mr. William Lobeda
IV-D-221	Mr. Bill D. Roumel
IV-D-223	Mr. Arnold Kese
IV-D-224; OAQPS-79-8/IV-D-11	Ms. Karen S. Kamp
IV-D-225	Mr. Ben H. Roseberry
IV-D-226	Mr. Daniel S. Dean
IV-D-227; IV-D-621	Mr. John C. Larsen
IV-D-228	Mr. and Mrs. Pete McDonell
IV-D-229	Mr. Harry D. Maxwell

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IV-D-230	Mrs. Matt Gunovich
IV-D-231	Mr. Adam S. Kreisman
IV-D-232	Mr. B.K. Arnberg, Jr.
IV-D-233	Mr. Alfred N. Johnson
IV-D-234	Mr. Henry Cox
IV-D-235	Mr. Homer T. Brown
IV-D-236	Ross and Mildred Rice
IV-D-237	Mr. Joseph M. Stadtler
IV-D-238	Mr. Robert F. Sylvanus
IV-D-239	Mr. Wallace H. Larson
IV-D-240	Mr. Art Alsos Carl T. Madsen, Inc.
IV-D-241; OAQPS-79-8/IV-D-12	Ms. Alice Spears
IV-D-242	Ms. Adah Green
IV-D-243	Mr. Charles E. Allen
IV-D-244	Mr. Robert Z. Primm Candid Photo Service, Inc.
IV-D-245	Ms. Kathleen M. Brainerd
IV-D-246	Mr. Raymond R. Webster
IV-D-247	Mr. F. Willard White
IV-D-248	Thomas and Rosemary Arnold
IV-D-249	Willis and Edith Powers
IV-D-250	Mr. & Mrs. Arthur Keug
IV-D-251	Ms. Eleanor Schaffer

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IV-D-252	Mr. Frank C. Hansen Unico Service & Engineering
IV-D-254	Mrs. Lorette Prettyman
IV-D-255; IV-D-337	Mr. Richard Tallman
IV-D-256	P.J. Dougherty
IV-D-257	Mr. Edward R. Kiehlmeier
IV-D-258	Ms. Alta F. Hyde
IV-D-259	Mr. Ernest Cooper
IV-D-260	Mr. Charles Mattheson
IV-D-261	Mrs. Ellen Manweiler
IV-D-262	R.D. Gallagher
IV-D-263	Richman and Forestbyne McNeil
IV-D-264	Mrs. Joe Sunich
IV-D-265	Mr. Ed Michalski
IV-D-266	Ms. Luvina Johnson
IV-D-267	Mr. Michael McIntyre
IV-D-268; IV-D-518	Mr. John Henderson
IV-D-269	Mr. Michael Evans
IV-D-270	Mr. Doss Bridges
IV-D-271	A. P. Konick
IV-D-272	Ms. Mae Brown
IV-D-273	Mr. Lowell Jorgenson
IV-D-274	Mr. Paul DiMaio
IV-D-275	Frank and Delores Keating

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IV-D-276	E.M. Krisman
IV-D-277	Mr. Jack Stutler
IV-D-278	Erwin and Patricia Myers
IV-D-279	K.S. Hammond
IV-D-280	Mrs. F.M. Larson
IV-D-281	Mr. Frank Dlanc
IV-D-282	Florence Irvin and John Jurovich
IV-D-284	Mr. William Dearborn
IV-D-285	Mr. Leon Cunningham
IV-D-286	Mr. Richard Lowery Electric Motor Service Co.
IV-D-287	Mr. Fred Young E. A. Wilcox Co.
IV-D-288	Mr. Kenneth Sprong Harbison-Walker Refractories
IV-D-289	Mr. C.M. Bevis Bevis & Assoc., Inc.
IV-D-290	Mr. Laurence Evoy Pierce County Medical
IV-D-291	Mr. George Leonhard Mount Rainier Council Boy Scouts of America
IV-D-292; IV-D-582; IV-D-668	Mr. Mike Cooney
IV-D-293	Mr. Joseph Prinse
IV-D-294	Mr. Lee Fedderly
IV-D-295	Ms. Marge Kunschak
IV-D-296	Mr. John Vipond Girard Wood Products

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IV-D-297	Mr. Kenneth Griswold
IV-D-298	Mr. Robert Laughlin
IV-D-299	Mr. Walter Ivey
IV-D-300	Mr. William Taylor Flohr Metal Fabricators
IV-D-301; OAQPS-79-8/IV-D-13	Ms. Sally Davidson
IV-D-303	Mr. R.E. Wendlandt Reliable Steel Fabricators
IV-D-304	Ms. Roxie Skidmore
IV-D-305	Mr. William Leonard
IV-D-306	Mrs. Robert Schanzenbach
IV-D-307	Mr. Hugh Williamson Pierce County Medical
IV-D-308	Mr. H. Eugene Quinn
IV-D-309	Mr. B.W. Truswell Wenatchee Silica Products, Inc.
IV-D-310	Mr. Don Zemek
IV-D-311	Mr. Justice Ashwell
IV-D-312	Harold and Anne Ransom
IV-D-313	Dr. and Mrs. Robert Knapp
IV-D-314	Dr. Richard G. Schoen
IV-D-315	Herbert and Charlotte Weston
IV-D-317	Mr. John Susanj
IV-D-318; IV-D-621	Mr. Coy Brown
IV-D-319; IV-D-621	Mr. Bill Weston
IV-D-320	Mr. and Mrs. John Reed

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IV-D-321	Ms. Ruth Brown
IV-D-322	Mr. George Austin Austin Mac, Inc.
IV-D-323	Mrs. Ivy Blackburn
IV-D-324	Mrs. Robert Kling
IV-D-325	Malcolm and Laurel Ross
IV-D-326	Mr. Floyd Martin
IV-D-327	Mrs. Elizabeth Pedersen
IV-D-328	Ms. Laure Nichols
IV-D-330	Mr. John Dyer
IV-D-331	Mr. Kenneth Taylor
IV-D-332	Mr. and Mrs. Fredrick Young
IV-D-333	Mrs. Robert Guddes
IV-D-334	Charles and Thelma Modie
IV-D-335	Ms. Mary L. Mullin
IV-D-336	Mr. John Daly
IV-D-338	Mr. Arlander Bell
IV-D-339	Mr. Walter Kunschak
IV-D-340	Mr. Donald Angle
IV-D-341	Pete and June Zaferin
IV-D-342	Mr. Allan Weydahl Nalco Chemical Co.
IV-D-343	Ms. Greta Dotson
IV-D-344	Mr. Charles Shaw
IV-D-345	Mr. Frank Puz
IV-D-346; OAQPS-79-8/IV-D-14	Ms. Shermaine Celine

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IV-D-347	Mr. Warren Harvey
IV-D-348	Mr. Frank Storizic
IV-D-349	W. Phelps
IV-D-350	Mrs. Chris Mortensen
IV-D-351	Mr. Robert Ellener
IV-D-353	Ms. Ella Phillips
IV-D-354	Mrs. Marjorie McMenamin
IV-D-355	Patrick and Nora Duggan
IV-D-356	Ms. Mary McCormack
IV-D-357	Mr. and Mrs. Ervin Lee
IV-D-358	Mr. J.M. Will Tam Engineering Corp.
IV-D-359	Mr. S. Evan Davies S. Evan Davies & Associates
IV-D-360	Ms. Betty J. Roberts
IV-D-361	Mr. and Mrs. Garland Cox
IV-D-362	Ms. Janet Jacobson
IV-D-363	Ms. Frances Coats
IV-D-364	Ms. Ellen Herigstad
IV-D-365	Mr. Fred Wise
IV-D-366	D.M. Manning
IV-D-367	Mr. and Mrs. W. Rieck
IV-D-368	Ms. Olga Williams
IV-D-369	Mr. Bill Merrill
IV-D-370	Mr. and Mrs. Ray Lunger

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IV-D-371	Mr. William Hanar
IV-D-372	Mr. Albert DiLoreto, Sr.
IV-D-373	Anne and Grant Whitley
IV-D-374	Mr. Louis Burkey
IV-D-376	Mr. Gerald Copp Public Utility District #1 of Chelan County
IV-D-377	Ms. Eva Malovich
IV-D-378	S. Behrman
IV-D-379	Mr. Raymond Wall
IV-D-380	Mr. Jim Wilhelmi, Jr. The Stationers, Inc.
IV-D-381	Mr. George Jowell
IV-D-382; IV-D-621	Mr. Floyd Williams
IV-D-384	Mr. Michael Fabb
IV-D-385	Mr. Ken Reaj
IV-D-386	Mr. William Cammarano, Jr. Cammarano Bros, Inc.
IV-D-387	Mr. M.J. Burgess
IV-D-388	Mr. D.S. Skeie Industrial Mineral Products, Inc.
IV-D-389	Mr. P. McDougal
IV-D-391	G.D. Shipley
IV-D-392	Robert and Jan Van de Mark
IV-D-393	G.S. and Bernice Tallman
IV-D-394	Ms. Mildred Wall

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IV-D-395	Mr. James Jacobsen
IV-D-396	M.C. Teats
IV-D-397	Mrs. June Gilson
IV-D-398	H.C. Bauman
IV-D-399	Mr. Ronald Roman
IV-D-400	Virginia and John Weaver
IV-D-401	Mr. Manfred Bell
IV-D-402	Mr. Edwin Briggs
IV-D-403	Mr. David Griffiths Cornell, Weinstein & Griffiths
IV-D-404	Ms. Kathryn Keller
IV-D-405; IV-D-621	Mr. Theodore Kennard B.A. McKenzie & Co.
IV-D-406	A.J. and Emily Charap
IV-D-407	Mrs. Edna Carlson
IV-D-408	S. Mladervich
IV-D-409	Mr. Glenn Roberts
IV-D-410	Mr. Frank D. Pupo Sam's Tire Service
IV-D-411	Ms. Carol Van Ginhoven
IV-D-412	Mr. Lloyd Skinner
IV-D-413; IV-D-677	Ms. Helen Gabel
IV-D-414; IV-D-677	Mr. Phillip Notermann
IV-D-415	Mr. Charles Wie
IV-D-416	Mr. Charles W. Olsen, Jr.
IV-D-417; IV-F-9	Mr. James Garrison

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IV-D-418	Mr. F. Andrew Bartels
IV-D-419	Mr. Philip Volker
IV-D-420	Ms. Patricia Howard
IV-D-421	Ms. Marianne Edsen
IV-D-422; IV-D-584	Demelza Costa, et al.
IV-D-423	Robert and Elnora Turver
IV-D-424	Mrs. Cheryl Curtis
IV-D-425	Mr. and Mrs. Harold Feley
IV-D-426	Walt and Kathy Hansen
IV-D-427	Rev. John Keliner Old St. Peter's Church
IV-D-428	Mr. Robert Burns
IV-D-430	Oleta Kerns
IV-D-431	Mr. Jon Fayst
IV-D-432	Mr. John Ellingson
IV-D-434	M. J. Bunnell
IV-D-436	Mr. G. Patrick Healy
IV-D-437	Ms. Joan Peterson
IV-D-439; IV-D-662; IV-D-676	Margie and Jeff Goulden
IV-D-440	Devitt and Debby Barnett
IV-D-441; IV-D-664; IV-D-676	Dr. John Van Ginhoven
IV-D-442	Mrs. Ray Hund
IV-D-443	Jeanne Snell and Frank Jackson Vashon-Maury Island Community Council

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IV-D-444	Mr. David A. Frew
IV-D-447; IV-D-786	Mr. Stephen Cant State of Washington Dept. of Labor & Industries
IV-D-448	Ms. Anita Fries Ohio State Clearinghouse
IV-D-449; IV-D-620; IV-D-621; IV-F-2[c]	Mr. Donald Robbins ASARCO, Inc.
IV-D-450	Mr. Ron Johnson
IV-D-451	Mr. Marion Brannon
IV-D-452	Ms. Cora Tolstrup
IV-D-454	Mr. Wayne Vanderflute
IV-D-455	Mr. F. Steven Doman
IV-D-456	Mr. Mark Peterson
IV-D-457	Mr. Robert Daniel
IV-D-458	Pat Frostad Motors & Controls Corp.
IV-D-459	Mr. Robert Lawson
IV-D-460	Mr. William Scott
IV-D-461	Mr. Bailey Nieder Tacoma Steel Supply
IV-D-462	Mr. Hugh Wild
IV-D-463	Ms. Elaine Thomas-Sherman
IV-D-464	Mr. Sidney Peyton
IV-D-465	Mr. Paul Foslien
IV-D-466	Mr. Sam Smyth
IV-D-467	Mr. Bill Cope

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IV-D-468	Mr. Albert Behar Pierce County Medical
IV-D-469	Ms. Sheila McCanta
IV-D-470	Mr. Edgar E. King
IV-D-471	Ms. Mary Chouinard
IV-D-472	Rose and Floyd Murphy
IV-D-473	Mr. Russell Johnson
IV-D-474	Ms. Helen Carnahan
IV-D-475	Ms. Lucille Olsen
IV-D-476	Beatrice and George Peterson
IV-D-477	Mr. and Mrs. Carroll Thompson
IV-D-478	Ms. Norma Rozmen
IV-D-479	Ms. Marian Ganz
IV-D-480	Mr. John Gaul
IV-D-481	Ms. Molly LeMay
IV-D-482	Mr. Joseph Petranovich
IV-D-483	Mr. Rohn Burgess
IV-D-484	Mr. Jack McGuirk
IV-D-486	Mr. John Watson
IV-D-487	Mrs. Georgann Gallagher
IV-D-488	Ms. Alvinia Hagen
IV-D-489	Mr. C. Mark Smith Tacoma-Pierce County Economic Development Board
IV-D-490	Mrs. Virginia Loomis
IV-D-491	Delmer Pitts

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IV-D-492	Mr. Robert Heaton
IV-D-493	Dr. Michael J. Jarvis
IV-D-494	Mr. Kenneth J. Haagen
IV-D-495	Mr. E.P. Stiles Pierce County Medical Bureau, Inc.
IV-D-496	Beverly and Lawrence Sawtelle
IV-D-497	Mr. and Mrs. K.W. Mueller
IV-D-498	Ms. Frances Johnson InterAcc Co.
IV-D-499	P. Fischer
IV-D-500	Ms. Betty M. Susan
IV-D-501	Mr. and Mrs. Duane Puyear
IV-D-502	Ms. Marie Bean
IV-D-503	Mr. Thomas G. Stoebe
IV-D-504	Mr. Malcolm N. Thompson United Steelworkers of America Local 25
IV-D-505	Ms. Doris Adams Smelterman's Federal Credit Union
IV-D-506	Mr. John Fink
IV-D-507	Mr. Wayne Harkness
IV-D-508	Herb and Shirley Godfrey
IV-D-509	Mr. and Mrs. A.R. Glenn
IV-D-510	Mr. Donald S. Leinum
IV-D-511	Mr. Paul A. Schulz
IV-D-512	Gary and Nancy Ackman

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IV-D-513	Mr. Bailey Nieder Columbia Energy Co., Inc.
IV-D-514	Mr. E.T. McGrath
IV-D-515	Ms. Beverly M. Migliore Brown University Department of Geological Sciences
IV-D-516	Mr. Fred H. Smith Cochrane Northwest, Inc.
IV-D-517	Ms. Margaret J. Rowan
IV-D-519	Mr. Robert R. Treanton Fick Foundry Co.
IV-D-520; IV-F-9	Ms. Rayna Holtz
IV-D-521	James and Jerry Brandfas
IV-D-522	Mr. Jerry Michael Carlson
IV-D-523	Mr. Wayne S. Moen
IV-D-524; IV-D-554; IV-D-660	Mr. Richard L. Franklin
IV-D-525	Mrs. E. Gerie Fortier
IV-D-526	Ms. Cheryl Kirkwold
IV-D-527	Mr. James D. Gray
IV-D-528	Mr. and Mrs. Al Wegleitner
IV-D-529	Ms. Carol A. Krona
IV-D-531	John and Doris Achman
IV-D-532	Mr. Robert D. Hall
IV-D-533	Mr. and Mrs. W.H. Buzzell
IV-D-534	Ms. Ruth M. Johnson
IV-D-535	Mr. Howard O. Huggard
IV-D-536	Mr. Kenneth Mensching and Family

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IV-D-537	Mr. Robert D. Budd
IV-D-538	Mr. Gregory B. Curwen Gierke, Curwen, Metzler & Bobrick
IV-D-539	Mr. and Mrs. Richard Perkins
IV-D-540	Mr. R.M. Kennard *et al*.
IV-D-541	Mr. T. Russell Mager
IV-D-542	Ronald and JoAnn Roberts
IV-D-543	Mr. and Mrs. Austin E. Atwood
IV-D-544	Ms. Ruby M. Martin
IV-D-545; IV-D-621	Mr. Clyde H. Hupp Pierce County Central Labor Council AFL-CIO
IV-D-546	Mr. Mike D. Perkins Don H. Perkins, Inc.
IV-D-547	Mrs. Leonard Berglund
IV-D-548	Mr. Marion W. Samuelson
IV-D-549; OAQPS-79-8/IV-D-15	Mr. Kenny Scott
IV-D-550	Mr. W.E. Lightfoot Coffman Engineers, Inc.
IV-D-551	Mr. Robert Reinhart.
IV-D-552	Mr. Robert F. Griffith
IV-D-553	Mr. W.A. Palmer
IV-D-555	Mr. and Mrs. Clifford Lakin
IV-D-556	Ms. Stephanie Colony
IV-D-557	Mr. Don H. Hinkley
IV-D-558	Mrs. Allan Lindstrom
IV-D-559	Mr. Bob L. Marshall

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IV-D-560	Mr. Kim de Rubertis
IV-D-561	Mr. A.B. Berg Industrial Mineral Products, Inc.
IV-D-562	Mr. David A. Pitts
IV-D-563	Mr. Paul E. Miller
IV-D-564	Mr. Duane A. Lindoff
IV-D-565	Mr. Richard Fundly
IV-D-566	Mr. Robert M. Helsell Wright Schuchart, Inc.
IV-D-567	Mr. R. Eccles
IV-D-568	Mr. Stephen F. Politeo Lilyblad Petroleum, Inc.
IV-D-569	Mr. Stan Sable
IV-D-570	Ms. Mary Susanj
IV-D-571	Ms. Katherine Spiratos Brown University
IV-D-572	Ms. Gretchen C. Gerish
IV-D-573; OAQPS-79-8/IV-D-17	Ms. Mary E. Cosaboom
IV-D-574	Ms. Ellen McComb Smith
IV-D-576; IV-D-699	Mr. Alf G. Anderson
IV-D-578	Adm. James S. Russell
IV-D-579; IV-F-9	Ms. Laurie Lehman
IV-D-580	Ms. Jennifer Paine
IV-D-581	Dr. Colleen R. Carey St. Luke's Medical Bldg.
IV-D-583	Toshio and Suzanne Akamatsu St. Joseph Hospital

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IV-D-585	Mr. Frank B. Terrill
IV-D-586	Ms. Lidona Shelley
IV-D-587	Mr. Brent Hartinger
IV-D-588	Ms. Constance Northey
IV-D-590	Mr. Michael J. Curley
IV-D-591	Ms. Susan M. Hodge
IV-D-592	Ms. Miriam Bishop
IV-D-594	Mr. John Candy
IV-D-595	Mr. Daniel M. Nelson Princeton University Department of Religion
IV-D-596	Mr. Dwight Holcombe
IV-D-597	Mr. Bruce Hoeft
IV-D-598	Mr. Lloyd D. Morrell
IV-D-599	Mr. Elliott McLean
IV-D-600	Ms. Betsy Allen
IV-D-601	Mr. Robert A. Erickson
IV-D-604; IV-D-609	Mr. Gerald S. Pade Friends of the Earth, Northwest Office
IV-D-605	Mr. and Mrs. A. Derby
IV-D-606; IV-D-689	Chris Combs
IV-D-607	Mr. Floyd Oles
IV-D-608; OAQPS-79-8/IV-D-18	Mr. Michael Gregory Sierra Club, Grand Canyon Chapter
IV-D-610	Paul and Sally Borgen

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IV-D-611	Mr. Ake Nygren Boliden Metall AB Sweden
IV-D-612	Mr. Lloyd Dodd L-M-D Electro-Silver Resource
IV-D-613	Ms. Virginia Mitchell
IV-D-614	Mr. James Tracht Pennwalt Corporation
IV-D-615	Mr. Marvin Williams Washington State Labor Council AFL-CIO
IV-D-616	Mr. Arne Bjornberg Mr. Rolf Svedberg Boliden Metall AB Sweden
IV-D-617; OAQPS-79-8/IV-D-19	Mr. David F. Zoll Chemical Manufacturers Assoc.
IV-D-618	Mr. Christopher DeMuth Office of Management & Budget
IV-D-619	Mr. James H. Boyd Newmont Mining Corporation
IV-D-620	Mr. R.J. Moore, F.C. Schafrick, and J.C. Martin Shea & Gardner (for ASARCO) Dr. Ian T.T. Higgins (for ASARCO)
IV-D-620; IV-F-2[c]	Mr. M.O. Varner, C.K. Guptill, C.R. Counts, and D.E. Holt ASARCO, Inc.
IV-D-622	Mr. Donald Moos Washington State Department of Ecology
IV-D-623	Mr. William Mitchell
IV-D-624	Mr. William Woolf

Docket Item Number	Commenter and Affiliation[b]
IV-D-625; OAQPS-79-8/IV-D-20	Mr. J.F. McKenzie Pacific Gas & Electric
IV-D-626; OAQPS-79-8/IV-D-21	Mr. Richard Kamp Smelter Crisis Education Project
IV-D-627	Mr. Thomas C. White
IV-D-628	Mr. E.E. Ives Stearns-Roger Engineering Corp.
IV-D-629	Mr. Brian Baird
IV-D-630	Mr. John Thomas
IV-D-631	Mr. Harmon Rulifson
IV-D-632	Mr. Robert Matthews
IV-D-633	Mr. Dennis Crumbley
IV-D-634	Mr. A.V.J. Prather and K.E. Blase Prather, Seeger, Doolittle & Farmer, Dr. S.H. Lamm (for Kennecott)
IV-D-634; IV-F-2[c]	Mr. R.A. Malone, Dr. L.S. Salmon, Dr. H.A. Lewis (for Kennecott)
IV-D-635	Mr. and Mrs. LeRoy Annis
IV-D-636	Ms. Evelyn Hildebrand
IV-D-637	Ms. Lucy Fitch
IV-D-638	Ms. Julie Reimer
IV-D-639	Mr. Larry Jones
IV-D-640	Mr. Floyd Hoffman, R.E. Johnson, and W.N. Miller Phelps Dodge Corporation
IV-D-640; IV-F-2[c]	Dr. S.H. Lamm, Mr. T.L. Cogut (for Phelps Dodge)
IV-D-640; IV-F-6[c]	Mr. F.P. Mendola Phelps Dodge Corporation

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IV-D-640; IV-D-704; OAQPS-79-8/IV-D-22; OAQPS-79-8/IV-D-32	A. Coy and S. Christiansen Evans, Kitchel & Jenckes (for Phelps Dodge)
IV-D-641; OAQPS-79-8/IV-D-23	Mr. Steven Kuhrtz New Jersey Dept. of Environmental Protection
IV-D-642; IV-D-750	Ms. Yvonne Thomas
IV-D-643	Ms. Jeanette Wakeman
IV-D-644	Ms. Katherine German
IV-D-645; IV-D-763; IV-D-770	Dr. Thomas Douglas Allied Medical Examiners
IV-D-646; IV-D-708 and 708a; IV-D-712; IV-D-767; IV-F-8	Mr. Michael Wright United Steelworkers of America
IV-D-647	Mr. Victor Gawley
IV-D-650	Mr. William Evan Wharton School of Finance University of Pennsylvania
IV-D-651; IV-D-653	Mr. James Nolan Puget Sound Air Pollution Control Agency
IV-D-652	Washington State Department of Social & Health Services
IV-D-654	Mr. Doug Sutherland Tacoma-Pierce County Board of Health
IV-D-655	Mrs. P.A. Aarrestad
IV-D-656	Mr. Joseph Shopin
IV-D-657	Mr. Warner Matson
IV-D-659	Mr. Dwight Kipp
IV-D-661	Mr. Douglas Branson
IV-D-663	David and Marti Lambert

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IV-D-664	Dr. John Van Ginhoven
IV-D-665	Mrs. Harold Hartinger
IV-D-669	Mr. Bradley Nakagawa, et al.
IV-D-671	Mr. Warren Wotten
IV-D-672	Ms. Annabelle Reed
IV-D-674	James and Debra Mains
IV-D-675	JonLee Joseph
IV-D-676; IV-D-677; IV-D-777	Sen. Slade Gorton U.S. Senate
IV-D-678	Ms. Susan Macrae Sierra Club
IV-D-679	Mr. Bernard Clouse
IV-D-680; IV-D-681	Mr. Leonard Roberts Office of Budget and Management Ohio State Clearinghouse
IV-D-682; IV-D-773	Mr. Floyd Frost, Ph.D. Washington Department of Social and Health Services
IV-D-684; IV-D-754; IV-D-780	Ms. Darcy L. Wright
IV-D-685	Mr. Jon Nuxoll
IV-D-686	Mrs. T.L. Radke
IV-D-688	Ms. Mary Clark Lee
IV-D-690	Mr. Jack Callinsky
IV-D-692; IV-D-787; IV-D-792; IV-D-793	Mr. Gerald McGrath
IV-D-693; IV-D-764; IV-D-791	Mr. Arthur Dammkoehler Puget Sound Air Pollution Control Agency

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IV-D-694	Donald and Shirley Ferris
IV-D-696	Ms. Gail Nordstrom
IV-D-697	Mr. Everett Lasher
IV-D-698; IV-D-731; IV-D-766; OAQPS-79-8/IV-D-26; OAQPS-79-8 /IV-D-31; OAQPS-79-8/IV-D-34	Mr. Robert Abrams Ms. Mary Lyndon New York State Department of Law
IV-D-700	Sven and Arvi Halstensen Star Electric
IV-D-701	Mr. Jon Hinck Greenpeace, U.S.A.
IV-D-704a; OAQPS-79-8/IV-D-28	Dr. Steven Lamm Consultants in Epidemiology & Occupational Health, Inc.
IV-D-705	Iskra Johnson
IV-D-706	Mr. John Roberts Engineering Plus, Inc.
IV-D-707	Ms. Margaret Wolf
IV-D-709	Mr. Larry Weakly
IV-D-711	Mr. Kurt Blase Prather, Seeger, Doolittle & Farmer
IV-D-713	Mr. Francis Hull
IV-D-715	Mr. Phil Nelson Washington State Department of Ecology
IV-D-717; IV-D-722	Mr. James Harris
IV-D-718	Ms. Eileen Goldgeier Brown University
IV-D-720	Ms. Lizabeth Brenneman
IV-D-724	Mr. William Rodgers, Jr. University of Washington School of Law

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IV-D-725	Mr. Hugh Mitchell
IV-D-726	Mr. Peter Andrews
IV-D-727	Mr. John Calnan
IV-D-728	Mr. Paul Karkainen
IV-D-729	Mr. Timothy Larson University of Washington Department of Civil Engineering
IV-D-730	Ms. Debbie Huntting
IV-D-732	Mr. Peter Murray Vashon Business Assoc.
IV-D-733	Mr. Dan Schueler
IV-D-734	Joseph and Karen Bartle
IV-D-735	Mr. Frank Hagel
IV-D-736	Mr. Robert Evans Purified Air Systems
IV-D-737	Washington Fair Share
IV-D-738; IV-D-751; IV-F-9	Ms. Jeanne Snell Vashon-Maury Island Community Council
IV-D-739	Mr. Douglas Easterling University of Wisconsin Department of Psychology
IV-D-740	Mr. Bruce Mann University of Puget Sound Department of Economics
IV-D-741	Dr. Jesse Tapp Seattle-King County Department of Public Health
IV-D-742	Mrs. Anna Marie Champlain
IV-D-743	Mr. Brian Kameus

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IV-D-744	Ms. Lin Noah
IV-D-746	Kelly Wheat
IV-D-747; OAQPS-79-8/IV-D-24	Dr. Thomas Godar American Lung Association
IV-D-748	Ms. Karen Langbauer
IV-D-752	Mr. Daniel Carlson
IV-D-753	Ms. Kathleen R. Harkins and Mr. Vernon W. Harkins
IV-D-755; IV-D-758; OAQPS-79-8/IV-D-25	Dr. W. Dale Overfield Neurology and Neurosurgery Associates of Tacoma, Inc., P.S.
IV-D-756	Ms. Penny Perka
IV-D-760; IV-D-774	Mr. Nils Lucander
IV-D-761	Ms. Mary-Win O'Brien United Steelworkers of America
IV-D-762	Mr. Richard Dale Smith Port of Tacoma
IV-D-765	Mr. G.D. Schurtz Kennecott
IV-D-768	Ms. Marjorie L. Williams and Ms. Fern Stephan
IV-D-769	Mr. Lance Neitzel
IV-D-771	Mr. Jeffrey Morris and Ms. Cheryl Platt
IV-D-772; OAQPS-79-8/IV-D-16	Dr. Philip J. Landrigan Centers for Disease Control NIOSH Robert A. Taft Laboratories
IV-D-775	Mr. Norman D. Dicks Member of Congress

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IV-D-776	Mr. Rod Chandler Member of Congress
IV-D-778	Mr. John McCain Member of Congress
IV-D-779	Ms. Katherine M. Hayes
IV-D-782	Mr. Ross Schlueter
IV-D-783	Mr. Gary A. Preston
IV-D-784	Mr. Dave Bateman
IV-D-785	Mr. Richard W. Rice Phelps Dodge Corporation
IV-D-788	Mr. R.A. Malone Kennecott
IV-D-789	Mr. M.O. Varner ASARCO, Inc.
IV-D-790	Mr. Richard W. Rice Phelps Dodge Corporation
IV-D-795; OAQPS-79-8/IV-D-9	Ms. Eve R. Simon
IV-D-800	Mr. J.D. Dumelle State of Illinois Pollution Control Board
IV-D-801	Mr. E.M. Sterling
IV-D-810	Ms. Denise Fort State of New Mexico Environmental Improvement Division
IV-D-811	Mr. F.C. Schafrick Shea & Gardner (for ASARCO)
IV-D-812	Mr. K.E. Blase Prather, Seeger, Doolittle & Farmer (for Kennecott)

Docket Item Number	Commenter and Affiliation[b]
IV-D-813	Mr. S.J. Christiansen Evans, Kitchel & Jenckes (for Phelps Dodge)
IV-D-814	Mr. Gordon Venable State of New Mexico Environmental Improvement Division
IV-F-1	Public Hearing transcript Thomas Jefferson Auditorium Department of Agriculture Washington, D.C. November 8, 1983
IV-F-2[c]	Mr. Blake Early Sierra Club
IV-F-3, -4, -5	Public Hearing transcripts Bicentennial Pavillion Tacoma, Washington November 2-4, 1983
IV-F-6[c]	Mr. Rolf Svedberg Boliden Metall AB Sweden
OAQPS-79-8/IV-D-1	Mr. Thomas J. Koralewski Libbey-Owens-Ford Company
OAQPS-79-8/IV-D-4	Mrs. Robert D. Hartwig
OAQPS-79-8/IV-D-5	Mr. H. E. Dean Plains Cotton Growers, Inc.
OAQPS-79-8/IV-D-8	Mr. Earl W. Sears National Cotton Council of America
OAQPS-79-8/IV-D-27	Mr. J.T. Barr Air Products and Chemicals, Inc.
OAQPS-79-8/IV-D-29	Dr. Samuel Milham, Jr. Washington State Department of Social and Health Services

Docket Item Number	Commenter and Affiliation[a]
OAQPS-79-8/IV-D-30	Dr. Ian Higgins University of Michigan School of Public Health

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[a] This appendix lists docket comment references cited in Parts I and II of this document.

[b] If no affiliation is indicated, commenter is speaking as a private citizen.

[c] Docket item contains written testimonies submitted by several commenters at the public hearings, which are similar to their oral presentations.

APPENDIX B

SMELTER ARSENIC MASS BALANCES

SMELTER ARSENIC MASS BALANCES

B.1 INTRODUCTION

This appendix contains diagrams showing current estimates of the distribution of arsenic in process materials, dusts, and flue gases at the 14 primary copper smelters considered "low-arsenic" at proposal. The distributions represent the baseline control situation, which includes currently installed controls and controls planned for the near future, prior to the imposition of any control requirements under this NESHAP. These figures are similar to those presented in Appendix F of low-arsenic BID, Volume I (EPA-450/3-83-010a), but most were revised since proposal in response to new information submitted by the respective copper companies.

The changes made since proposal and the rationale for the changes are discussed in Section I-4 of this document. All assumptions concerning baseline configurations are unchanged, except for Phelps Dodge-Ajo (Figure B-10). At proposal, oxy-sprinkle smelting was assumed for the Ajo baseline configuration because this smelter was planning under a consent decree to convert to this type of smelting. Since the smelter has determined that it will not now carry out this modification, EPA has revised the Ajo mass balance to reflect the operation of the present reverberatory furnace configuration. Other changes were made primarily because of new information received on smelter arsenic inputs and the distribution of arsenic exiting smelting vessels and converters.

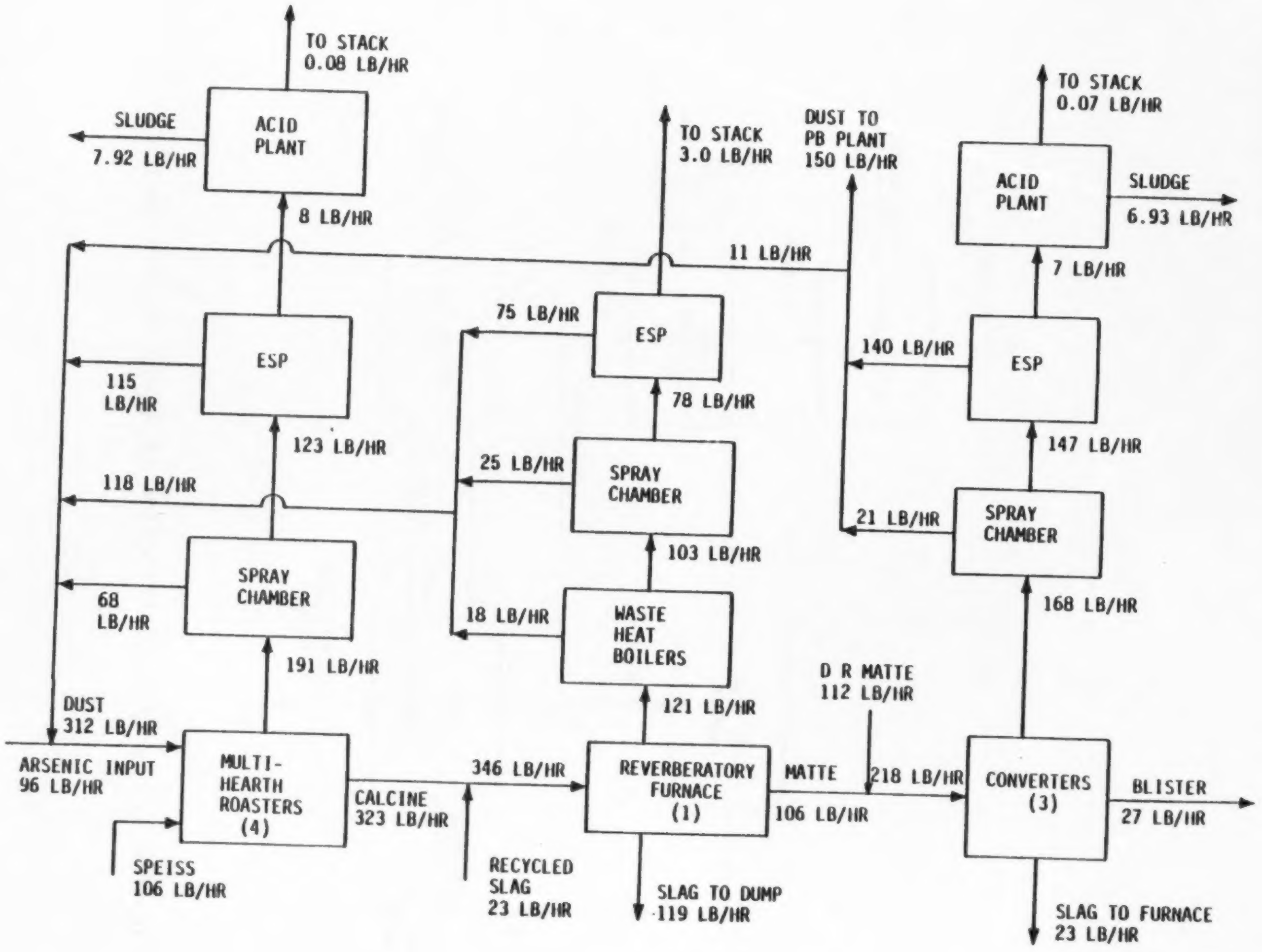

Figure B-1. Arsenic Distribution at ASARCO-El Paso Smelter

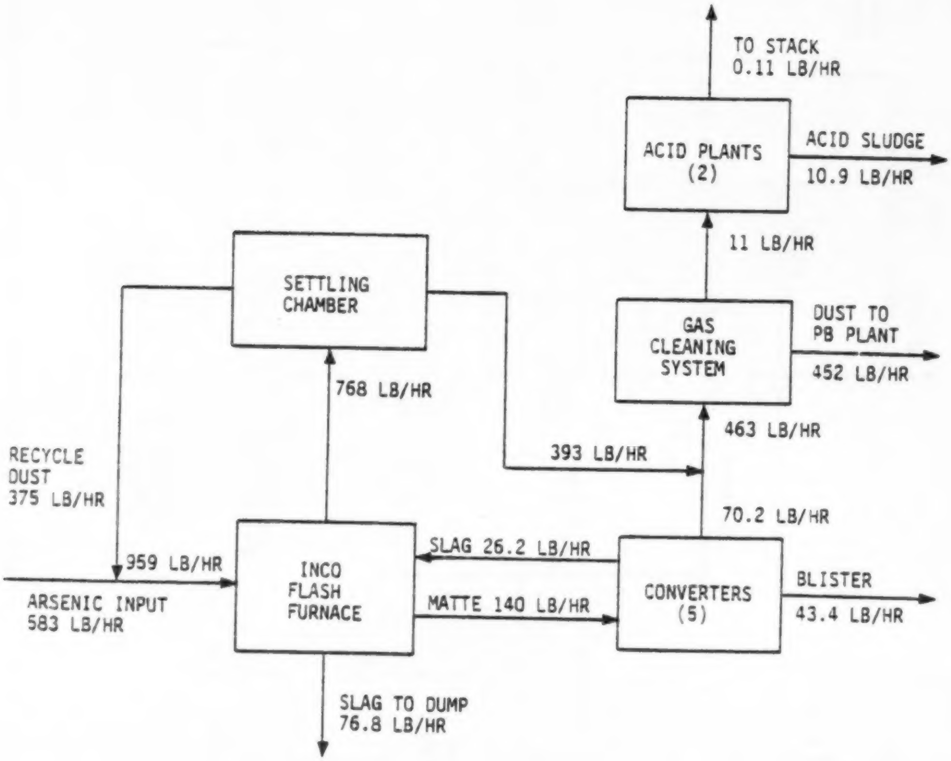

Figure B-2. Arsenic Distribution at ASARCO-Hayden Smelter

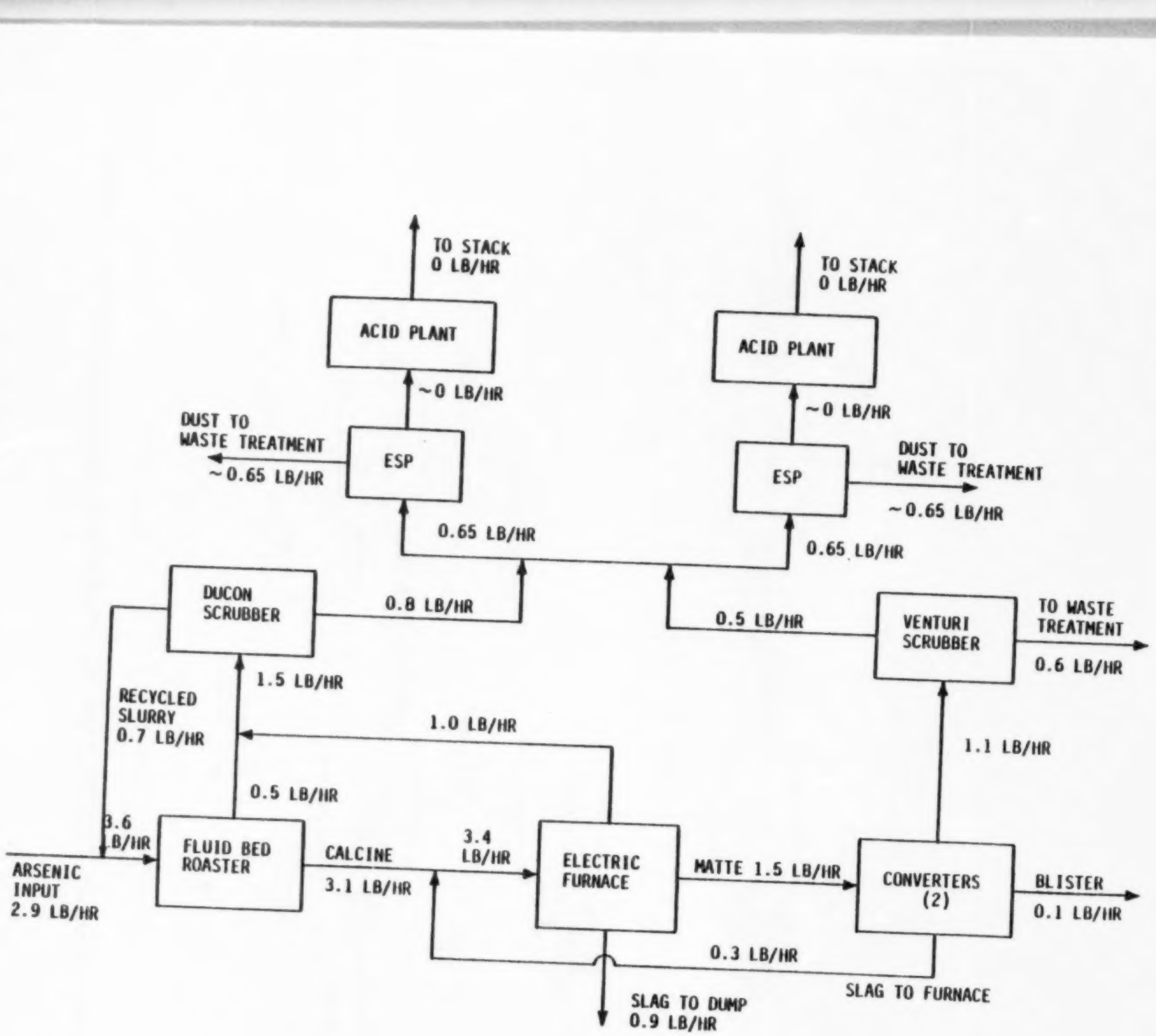

Figure B-3. Arsenic Distribution at Tennessee Chemical Co.-Copperhill Smelter

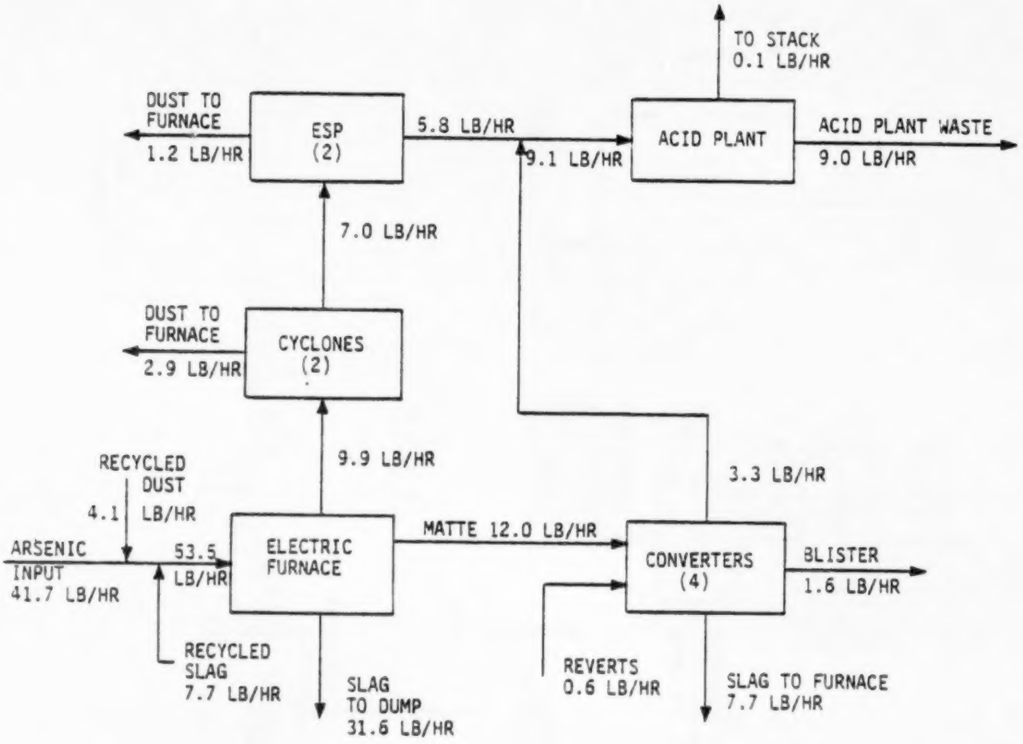

Figure B-4. Arsenic Distribution at Inspiration Consolidated-Miami Smelter

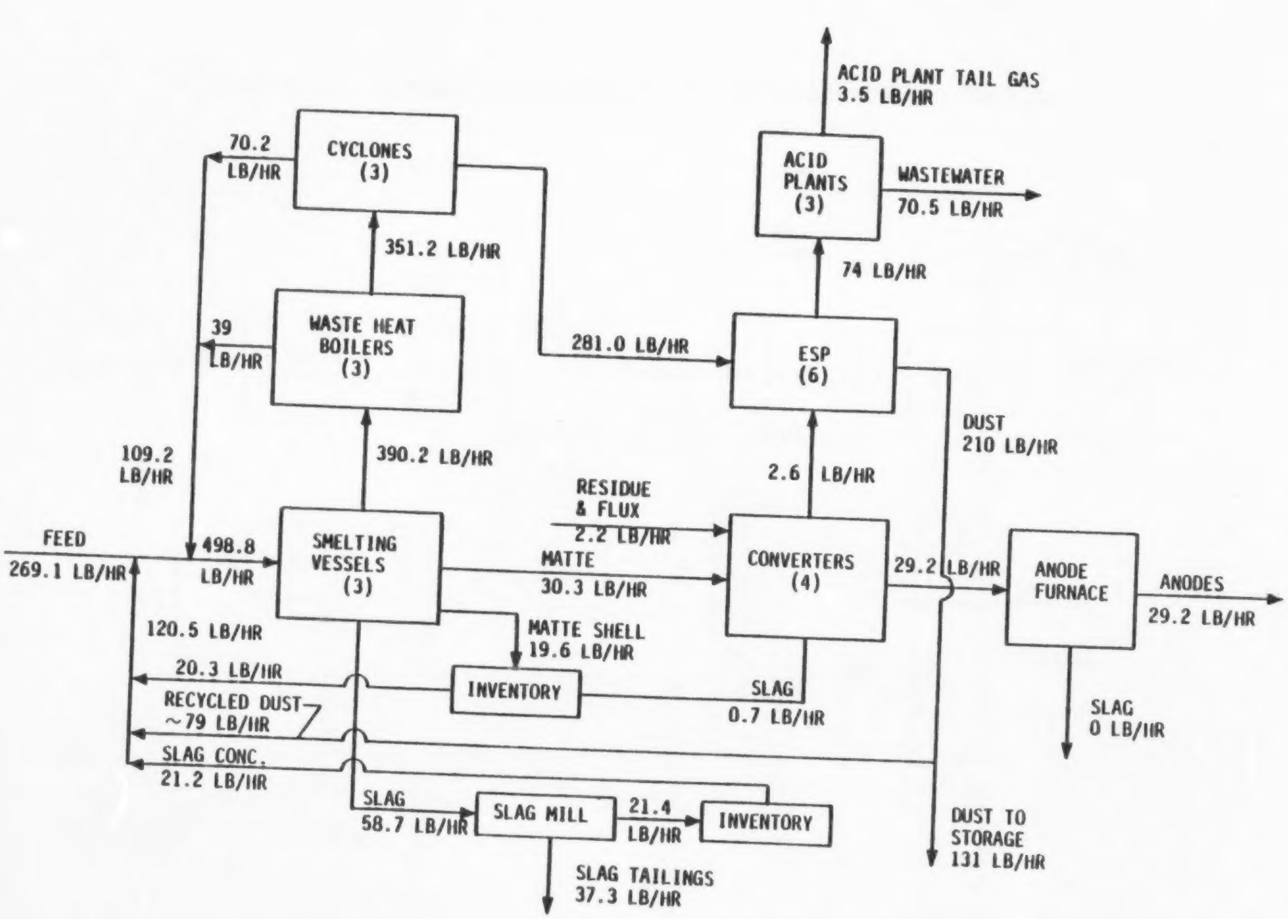

Figure B-5. Arsenic Distribution at Kennecott-Utah Smelter

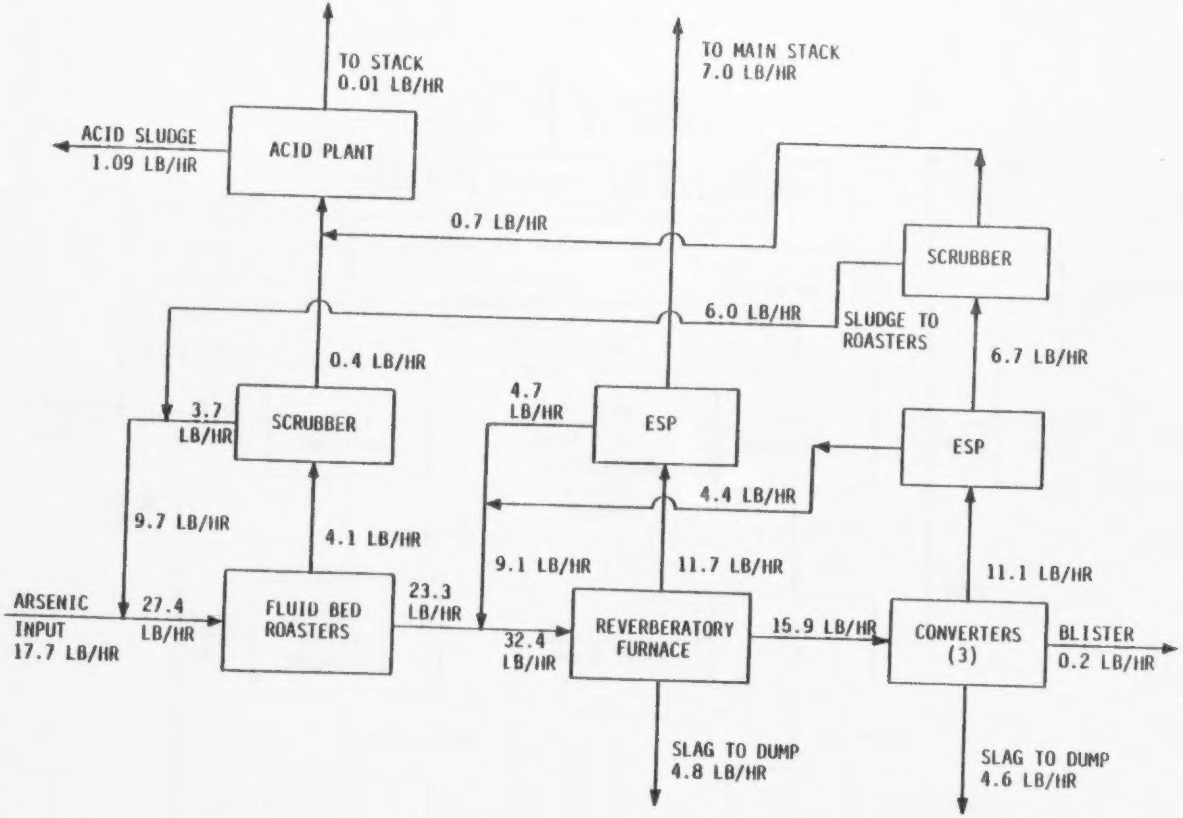

Figure B-6. Arsenic Distribution at Kennecott-Hayden Smelter

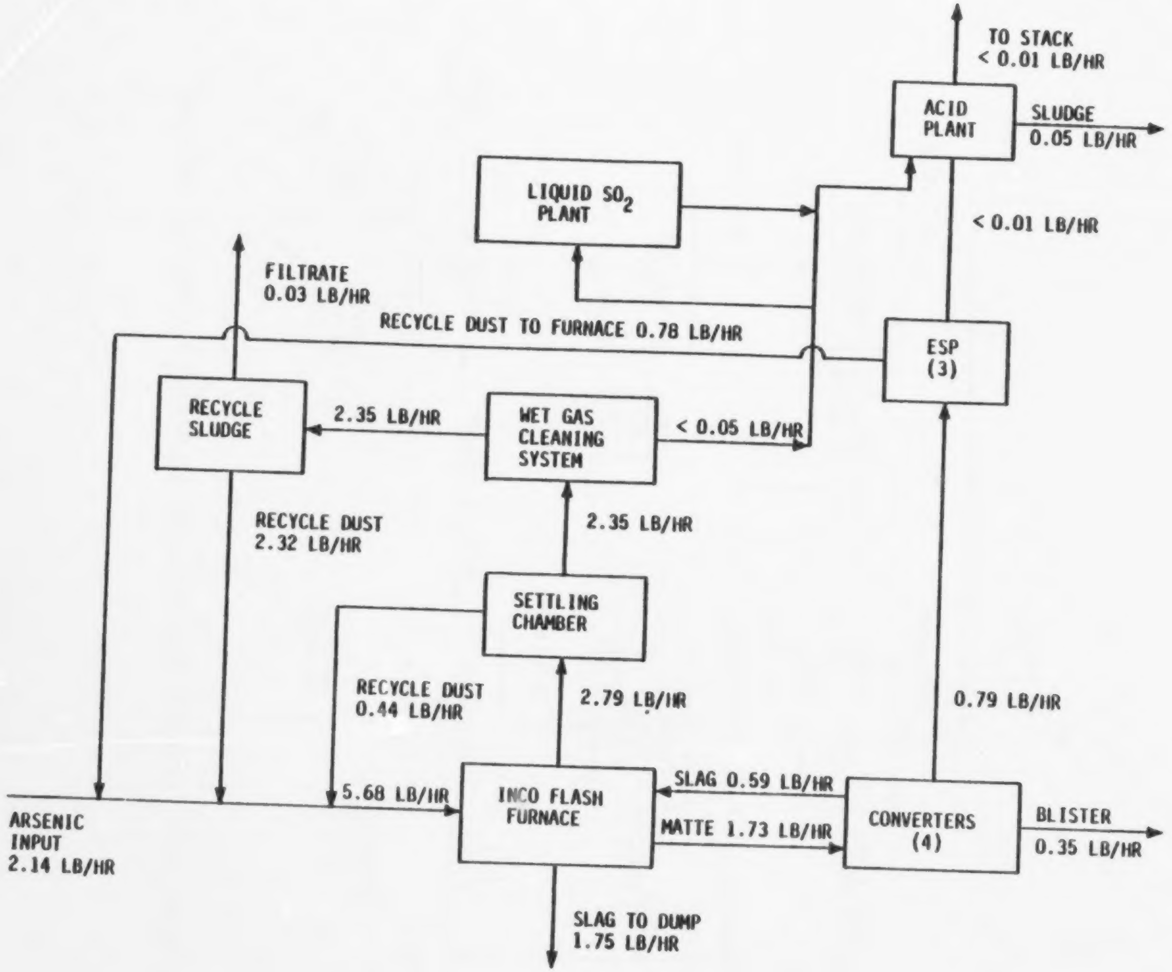

Figure B-7. Arsenic Distribution at Kennecott-Hurley Smelter

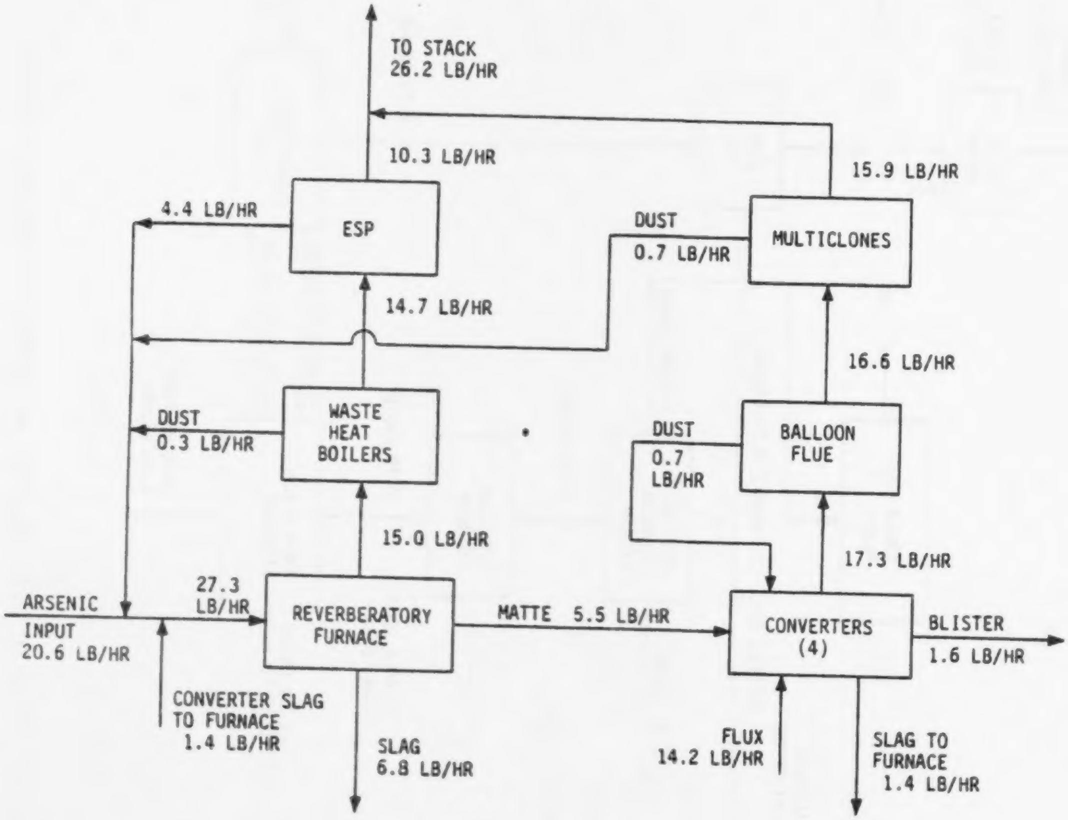

Figure B-8. Arsenic Distribution at Kennecott-McGill Smelter

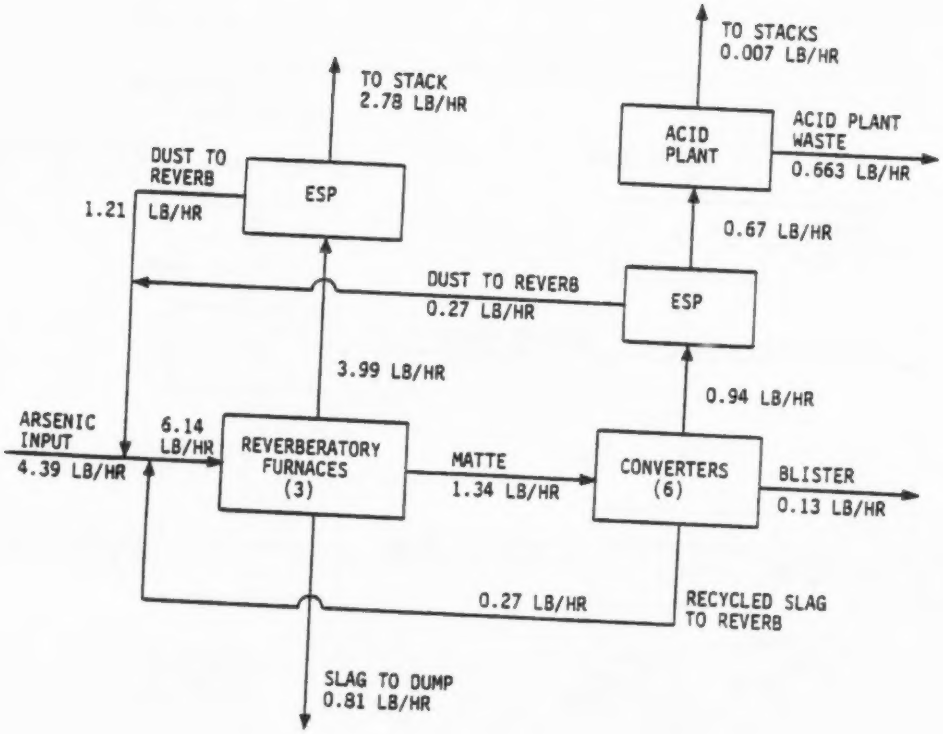

Figure B-9. Arsenic Distribution at Magma-San Manuel Smelter

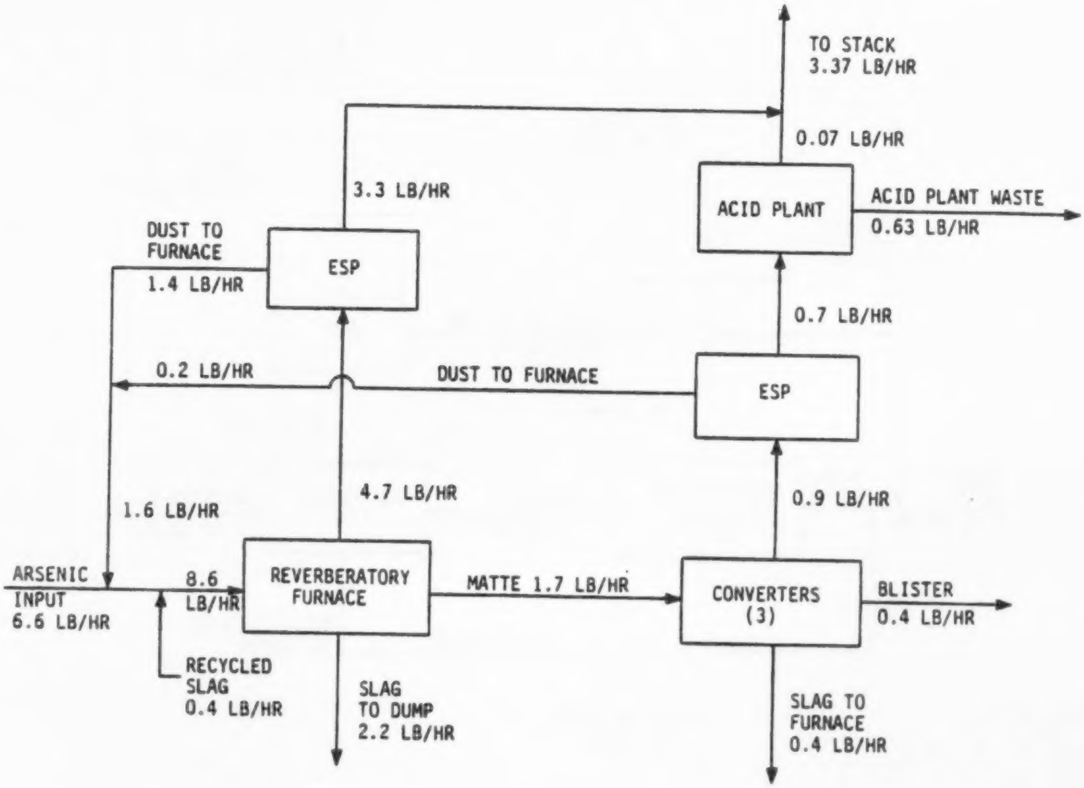

Figure B-10. Arsenic Distribution at Phelps Dodge-Ajo Smelter

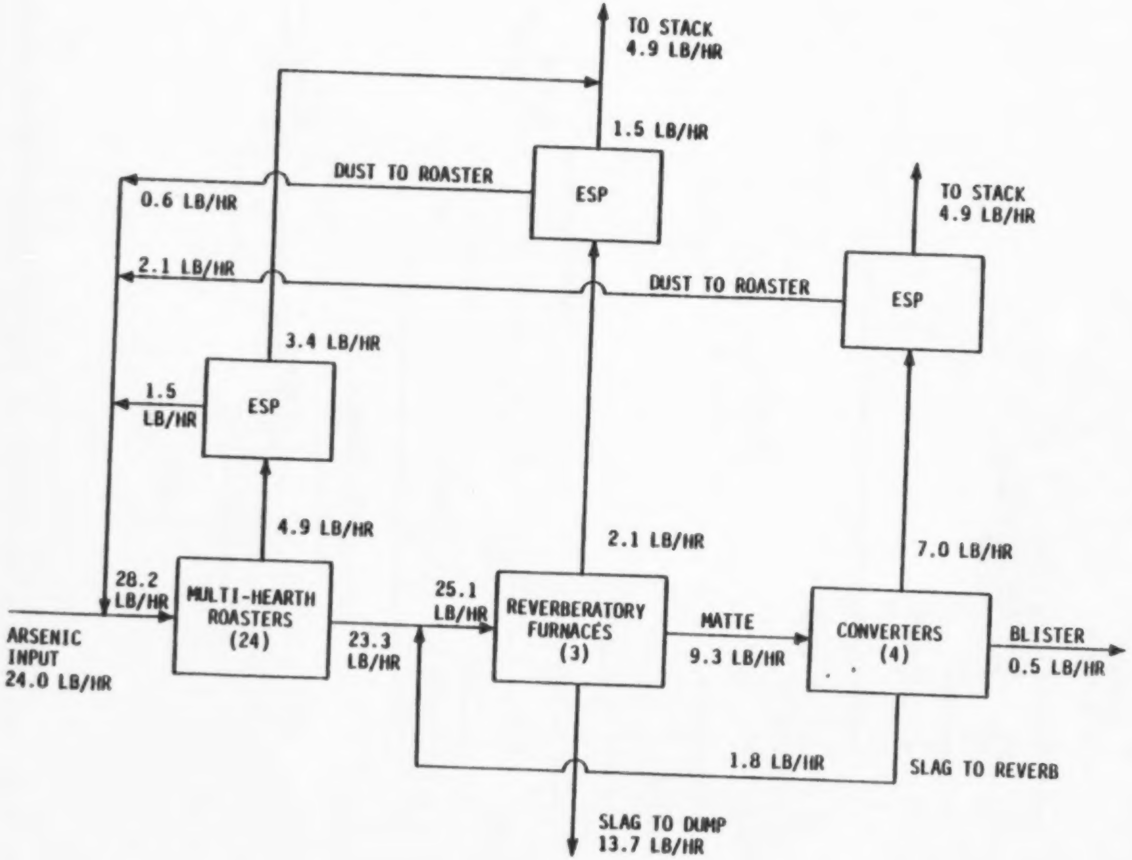

Figure B-11. Arsenic Distribution at Phelps Dodge-Douglas Smelter

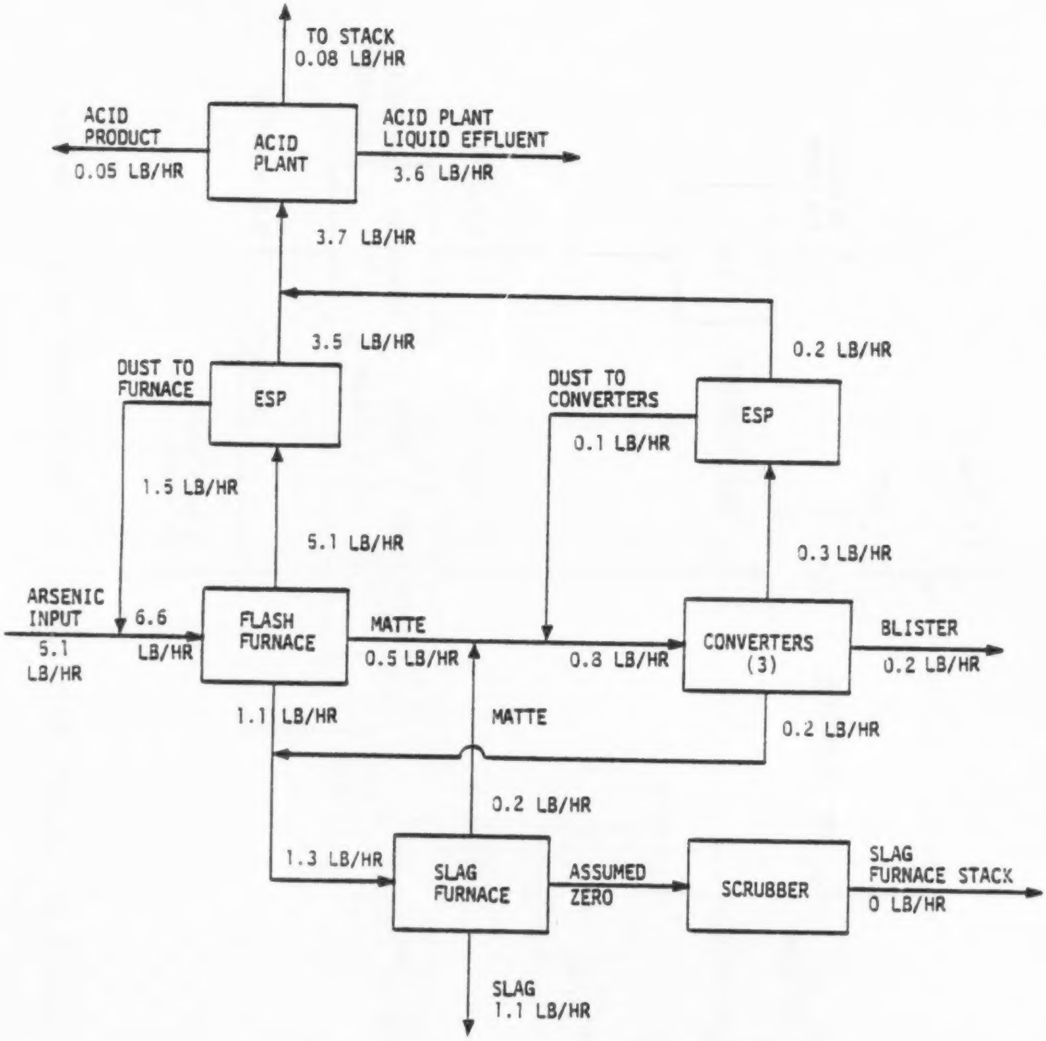

Figure B-12. Arsenic Distribution at Phelps Dodge-Hidalgo Smelter

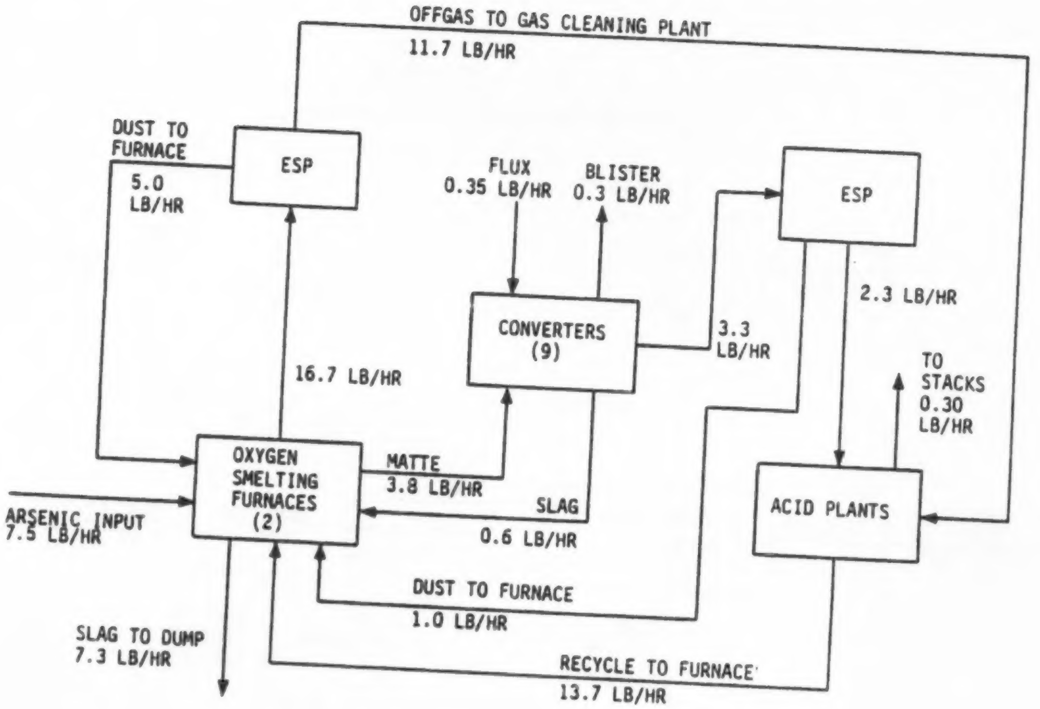

Figure B-13. Arsenic Distribution at Phelps Dodge-Morenci Smelter

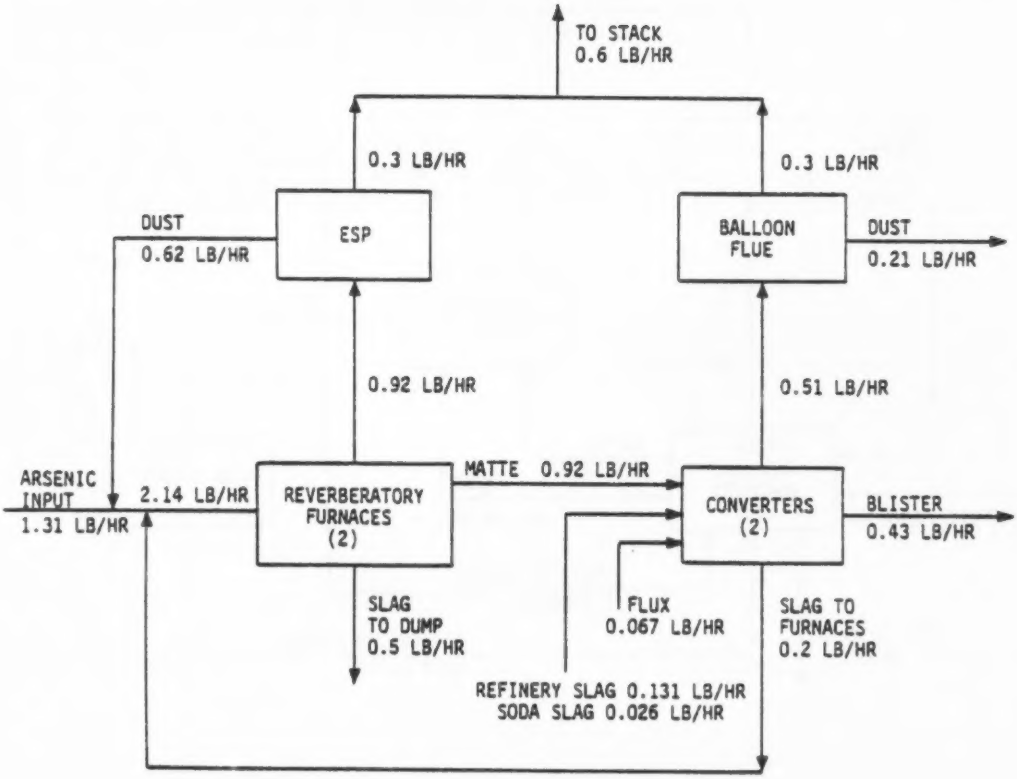

Figure B-14. Arsenic Distribution at Copper Range-White Pine Smelter

APPENDIX C

INORGANIC ARSENIC RISK ASSESSMENT FOR PRIMARY COPPER SMELTERS

INORGANIC ARSENIC RISK ASSESSMENT FOR LOW-ARSENIC PRIMARY COPPER SMELTERS

C.1 INTRODUCTION

C.1.1 Overview

The quantitative expressions of public cancer risks presented in this appendix are based on (1) a dose-response model that numerically relates the degree of exposure to airborne inorganic arsenic to the risk of getting lung cancer, and (2) numerical expressions of public exposure to ambient air concentrations of inorganic arsenic estimated to be caused by emissions from stationary sources. Each of these factors is discussed briefly below and details are provided in the following sections of this appendix.

C.1.2 The Relationship of Exposure to Cancer Risk

The relationship of exposure to the risk of contracting lung cancer is derived from epidemiological studies in occupational settings rather than from studies of excess cancer incidence among the public. The epidemiological methods that have successfully revealed associations between occupational exposure and cancer for substances such as asbestos, benzene, vinyl chloride, and ionizing radiation, as well as for inorganic arsenic, are not readily applied to the public sector, with its increased number of confounding variables, much more diverse and mobile exposed population, lack of consolidated medical records, and almost total absence of historical exposure data Given such uncertainties, EPA considers it improbable that any association, short of very large increases in cancer, can be verified in the general population with any reasonable certainty by an epidemiological study. Furthermore, as noted by the National Academy of Sciences (NAS)[1], "...when there is exposure to a material, we are not starting at an origin of zero cancers. Nor are we starting at an origin of zero carcinogenic agents in our environment. Thus, it is likely that any carcinogenic agent added to the environment will act by a particular mechanism on a particular cell population that is already being acted on by the same mechanism to induce cancers." In discussing experimental dose-response curves, the NAS observed that most information on carcinogenesis is derived from studies of ionizing radiation with experimental animals and with humans which indicate a linear no-threshold dose-response relationship at low doses. They added that although some evidence exists for thresholds in some animal tissues, by and large, thresholds have not been established for most tissues. NAS concluded that establishing such low-dose thresholds "...would require massive, expensive, and impractical experiments ..." and recognized that the U.S. population "...is a large, diverse, and genetically heterogeneous group exposed to a large variety of toxic agents." This fact, coupled with the known genetic variability to carcinogenesis and the predisposition of some individuals to some form of cancer, makes it extremely difficult, if not impossible, to identify a threshold.

For these reasons, EPA has taken the position, shared by other Federal regulatory agencies, that in the absence of sound scientific evidence to the contrary, carcinogens should be considered to pose some cancer risk at any exposure level. This no-threshold presumption is based on the view that as little as one molecule of a carcinogenic substance may be sufficient to transform a normal cell into a cancer cell. Evidence is available from both the human and animal health literature that cancers may arise from a single transformed cell. Mutation research with ionizing radiation in cell cultures indicates that such a transformation can occur as the result of interaction with as little as a single cluster of ion pairs. In reviewing the available data regarding carcinogenicity, EPA found no compelling scientific reason to abandon the no-threshold presumption for inorganic arsenic.

In developing the exposure-risk relationship for inorganic arsenic, EPA has assumed that a linear no-threshold relationship exists at and below the levels of exposure reported in the epidemiological studies of occupational exposure. This means that any exposure to inorganic arsenic is assumed to pose some risk of lung cancer and that the linear relationship between cancer risks and levels of public exposure is the same as that between cancer risks and levels of occupational exposure. EPA believes that this assumption is reasonable for public health protection in light of presently available information. However, it should be recognized that the case for the linear no-threshold dose-response relationship model for inorganic arsenic is not quite as strong as that for carcinogens which interact directly or in metabolic form with DNA. Nevertheless, there is no adequate basis for dismissing the linear no-threshold model for inorganic arsenic. Assuming that exposure has been accurately quantified, it is the Agency's belief that the exposure-risk relationship used by EPA at low concentrations represents only a plausible upper-limit risk estimate in the sense that the risk is probably not higher than the calculated level and could be much lower.

The numerical constant that defines the exposure-risk relationship used by EPA in its analysis of carcinogens is called the unit risk estimate. The unit risk estimate for an air pollutant is defined as the lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed throughout their lifetimes (about 70 years) to an average concentration of 1 $\mu g/m^3$ of the agent in the air which they breathe. Unit risk estimates are used for two purposes: (1) to compare the carcinogenic potency of several agents with each other, and (2) to give a crude indication of the public health risk which might be associated with estimated air exposure to these agents.

The unit risk estimate for inorganic arsenic that is used in this appendix was prepared by combining the five different exposure-risk numerical constants developed from four occupational studies.[2] The methodology used to develop the unit risk estimate from the four studies is described in C.2 below.

C.1.3 Public Exposure

The unit risk estimate is only one of the factors needed to produce quantitative expressions of public health risks. Another factor needed is a numerical expression of public exposure, i.e., the numbers of people exposed to the various concentrations of inorganic arsenic. The difficulty of defining public exposure was noted by the National Task Force on Environmental Cancer and Health and Lung Disease in their 5th Annual Report to Congress, in 1982.[3] They reported that "...a large proportion of the American population works some distance away from their homes and experience different types of pollution in their homes, on the way to and from work, and in the workplace. Also, the American population is quite mobile, and many people move every few years." They also noted the necessity and difficulty of dealing with long-term exposures because of "...the long latent period required for the development and expression of neoplasia [cancer]..."

[The reader should note that the unit risk estimate has been changed from that value used in the inorganic NESHAP proposal as a result of EPA's analysis of several occupational epidemiological studies that have recently been completed.]

EPA's numerical expression of public exposure is based on two estimates. The first is an estimate of the magnitude and location of long-term average ambient air concentrations of inorganic arsenic in the vicinity of emitting sources based on air dispersion modeling using long-term estimates of source emissions and meteorological conditions. The second is an estimate of the number and distribution of people living in the vicinity of emitting sources based on 1980 Bureau of Census data which "locates" people by population centroids in census tract areas. The people and concentrations are combined to produce numerical expressions of public exposure by an approximating technique contained in a computerized model. The methodology is described in C.3 below.

C.1.4 Public Cancer Risks

By combining numerical expressions of public exposure with the unit risk estimate, two types of numerical expressions of public cancer risks are produced. The first, called individual risk, relates to the person or persons estimated to live in the area of highest concentration as estimated by the computer model. Individual risk is expressed as "maximum lifetime risk." As used here, the work "maximum" does not mean the greatest possible risk of cancer to the public. It is based only on the maximum annual average exposure estimated by the procedure used. The second, called aggregate risk, is a summation of all the risks to people estimated to be living within the vicinity (usually within 50 kilometers) of a source and is customarily summed for all the sources in a particular category. The aggregate risk is expressed as incidences of cancer among all of the exposed population after 70 years of exposure; for convenience, it is often divided by 70 and expressed as cancer incidences per year. These calculations are described in more detail in C.4 below.

There are also risks of nonfatal cancer and other potential health effects, depending on which organs receive the exposure. No numerical expressions of such risks have been developed; however, EPA considers all of these risks when making regulatory decisions on limiting emissions of inorganic arsenic.

C.2 THE UNIT RISK ESTIMATE FOR INORGANIC ARSENIC[2]

The following discussion is summarized from a more detailed description of the Agency's derivation of the inorganic arsenic unit risk estimate as found in EPA's "Health Assessment Document for Inorganic Arsenic" (EPA-600/8-83-021F).

C.2.1 The Linear No-Threshold Model for Estimation of Unit Risk Based on Human Data (General)

The methodologies used to arrive at quantitative estimates of risk must be capable of being implemented using the data available in existing epidemiologic studies of exposure to airborne arsenic. In order to extrapolate from the exposure levels and temporal exposure patterns in these studies to those for which risk estimates are required, it is assumed that the age-specific mortality rate of respiratory cancer per year per 100,000 persons for a particular 5-year age interval, i, can be represented using the following linear absolute or additive risk model:

$$a_i(D)=a_i + 100{,}000a'D \qquad (1)$$

With this model, a_i is the age-specific mortality rate per year of respiratory cancer in a control population not exposed to arsenic, a' is a parameter representing the potential of airborne arsenic to cause respiratory cancer, and D is some measure of the exposure to arsenic up to the ith age interval. For example, D might be the cumulative dose in years-$\mu g/m^3$, the cumulative dose neglecting exposure during the last 10 years prior to the ith age interval, or the average dose in $\mu g/m^3$ over some time period prior to the ith age interval. The forms to be used for D are constrained by the manner in which dose was treated in each individual epidemiologic study. At low exposures the extra lifetime probability of respiratory cancer mortality will vary correspondingly (e.g., linearly).

The dose-response data available in the epidemiologic studies for estimating the parameters in these models consists primarily of a dose measure D_j for the jth exposure group, the person-years of observation Y_j, the observed number of respiratory cancer deaths O_j, and the number E_j of these deaths expected in a control population with the same sex and age distribution as the exposure group. The expected number E_j is calculated as

$$E_j = \sum_i Y_{ji}a_i\ 100{,}000 \qquad (2)$$

where Y_{ji} is the number of person-years of observation in the ith age category and the jth exposure group ($Y_j = \sum_i Y_{ji}$). This is actually a simplified representation, because the calculation also takes account of the change in the age-specific incidence rates with absolute time. The expected number of respiratory cancer deaths for the ith exposure group is

$$E(O_j) = \sum_i Y_{ji}\ (a_i + 100{,}000a'D_j)/100{,}000$$

$$= E_j + a'Y_jD_j \qquad (3)$$

under the linear absolute risk model. Consequently, $E(O_j)$ can be expressed in terms of quantities typically available from the published epidemiologic studies.

Making the reasonable assumption that O_j has a Poisson distribution, the parameter a' can be estimated from the above equation using the method of maximum likelihood. Once this parameter is estimated, the age-specific mortality rates for respiratory cancer can be estimated for any desired exposure pattern.

To estimate the corresponding additional lifetime probability of respiratory cancer mortality, let $b_1,\ldots,b_{18}$ be the mortality rates, in the absence of exposure, for all cases per year per 100,000 persons for the age intervals 0-4, 5-9,..., 80-84, and 85+, respectively; let $a_1,\ldots,a_{18}$ represent the corresponding rates for malignant neoplasms of the respiratory system. The probability of survival to the beginning of the ith 5-year age interval is estimated as

$$\prod_{j=1}^{i-1} [1 - 5b_j/100{,}000] \qquad (4)$$

Given survival to the beginning of age interval i, the probability of dying of respiratory cancer during this 5-year interval is estimated as

$$5a_i/100{,}000 \qquad (5)$$

The probability of dying of respiratory cancer given survival to age 85 is estimated as a_{18}/b_{18}. Therefore, the probability of dying of respiratory cancer in the absence of exposure to arsenic can be estimated by:

$$P_0 = \sum_{i=1}^{17} [5a_i/100{,}000) \prod_{j=1}^{i-1} (1-5b_j/100{,}000)] \qquad (6)$$
$$+(a_{18}/b_{18}) \prod_{j=1}^{17} (1 - 5b_j/100{,}000)$$

Here the mortality rates a_i apply to the target population for which risk estimates are desired, and consequently will be different from those in (1)-(5), which applied to the epidemiologic study cohort. If the 1976 U.S. mortality rates (male, female, white, and non-white combined) are used in this expression, then $P_0 = 0.0451$.

To estimate the probability P_{EP} of respiratory cancer mortality when exposed to a particular exposure pattern EP, the formula (6) is again used, but a_i and b_i are replaced by $a_i(D_i)$ and $b_i(D_i)$, where D_i is the exposure measure calculated for the ith age interval from the exposure pattern EP. For example, if the dose measure used in (1) is cumulative dose to the beginning of the ith age interval in $\mu g/m^3$-years, and the exposure pattern EP is a lifetime exposure to a constant level of 10 $\mu g/m^3$, then $D_i = (i-1)(5)(10)$, where the 5 accounts for the fact that each age interval has a width of 5 years. The additional risk of respiratory cancer mortality is estimated as

$$P_{EP} - P_0 \qquad (7)$$

If the exposure pattern EP is constant exposure to 1 $\mu g/m^3$, then $P_{EP} - P_0$ is called the "unit risk."

This approach can easily be modified to estimate the extra probability of respiratory cancer mortality by a particular age due to any specified exposure pattern.

C.2.2 Risk Estimates from Epidemiologic Studies

Prospective studies of the relationship between mortality and exposure to airborne arsenic have been conducted for the Anaconda Montana smelter and the Tacoma, Washington smelter. Table C.1 summarizes the fit of the absolute linear risk model, to dose-response data from 4 different studies at the two smelters. (See tne "Health Assessment Document for Inorganic Arsenic," Chapter 7, EPA-600/ 8-83-021F for a detailed description of occupational studies.) Table C.1 also displays the carcinogenic potencies a'. It should be noted that the potencies estimated from different models are in different units, and are therefore not comparable.

The estimated unit risk is presented for each fit for which the chi-square goodness-of-fit p-value is greater than 0.01. The unit risks derived from linear models--8 in all--range from 0.0013 to 0.0136. The largest of these is from the Ott et al. study, which probably is the least reliable for developing quantitative estimates, and which also involved exposures to pentavalent arsenic, whereas the other studies involved trivalent arsenic. The unit risks derived from the linear absolute-risk models are considered to be the most reliable; although derived from 5 sets of data involving 4 sets of investigators and 2 distant exposed populations, these estimates are quite consistent, ranging from 0.0013 to 0.0076.

To establish a single point estimate, the geometric mean for data sets is obtained within distinct exposed populations, and the final estimate is taken to be the geometric mean of those values. This process is illustrated in Table C.2.

Table C.1
Summary of Quantitative Risk Analyses

Exposed Population	Study and Data Source	Model	Results of Goodness-of-Fit Test		
			x^2(d.f.)	p-value	"unit" risk[a]
Anaconda smelter workers	Lee-Feldstein (heavy exposure omitted)	absolute risk	12.7(5)	0.025	2.80(-3)[b]
	Higgins et al.	absolute risk	1.2(3)	0.75	4.90(-3)
	Brown & Chu	absolute risk	7.01(7)	0.41	1.25(-3)
ASARCO smelter workers	Enterline & Marsh (zero lag)	absolute risk	5.5(4)	0.24	6.81(-3)
	Enterline & Marsh (10-year lag)	absolute risk	7.0(4)	0.14	7.60(-3)

---

[a] Additional lifetime risk of respiratory cancer mortality from lifetime environmental exposure to 1 μgm^3 arsenic.

[b] 2.80 (-3) means 2.80×10^{-3}

TABLE C.2 COMBINED UNIT RISK ESTIMATES FOR ABSOLUTE RISK LINEAR MODELS

Exposure Source	Study	Unit Risk	Geometric Mean Unit Risk	Final Estimated Unit Risk
Anaconda smelter	Brown & Chu	1.25×10^{-3}	2.56×10^{-3}	4.29×10^{-3}
	Lee Feldstein	2.80×10^{-3}		
	Higgins et al.	4.90×10^{-3}		
ASARCO smelter	Enterline & Marsh	6.81×10^{-3} 7.60×10^{-3}	7.19×10^{-3}	

C.3 QUANTITATIVE EXPRESSIONS OF PUBLIC EXPOSURE TO INORGANIC ARSENIC EMITTED FROM LOW-ARSENIC PRIMARY COPPER SMELTERS

C.3.1 EPA's Human Exposure Model (HEM) (General)

EPA's Human Exposure Model is a general model capable of producing quantitative expressions of public exposure to ambient air concentrations of pollutants emitted from stationary sources. HEM contains (1) an atmospheric dispersion model, with included meteorological data, and (2) a population distribution estimate based on Bureau of Census data. The input data needed to operate this model are source data, e.g., plant location, height of the emission release point, and volumetric rate of release temperature of the off-gases. Based on the source data, the model estimates the magnitude and distribution of ambient air concentrations of the pollutant in the vicinity of the source. The model is programmed to estimate these concentrations for a specific set of points within a radial distance of 50 kilometers from the source. If the user wishes to use a dispersion model other than the one contained in HEM to estimate ambient air concentrations in the vicinity of a source, HEM can accept the concentrations if they are put into an appropriate format.

Based on the radial distance specified, HEM numerically combines the distributions of pollutant concentrations and people to produce quantitative expressions of public exposure to the pollutant.

C.3.1.1 Pollutant Concentrations Near a Source

The HEM dispersion model is a climatological model which is a sector-averaged gaussian dispersion algorithm that has been simplified to improve computational efficiency.[5] Stability array (STAR) summaries are the principal meteorological input to the HEM dispersion model. STAR data are standard climatological frequency-of-occurence summaries formulated for use in EPA models and available for major U.S. meteorological monitoring sites from the National Climatic Center, Asheville, N.C. A STAR summary is a joint frequency-of-occurence of wind speed, atmospheric stability, and wind direction, classified according to Pasquill's categories. The STAR summaries in

HEM usually reflect five years of meteorological data for each of 314 sites nationwide. The model produces polar coordinate receptor grid points consisting of 10 downwind distances located along each of 16 radials which represent wind directions. Concentrations are estimated by the dispersion model for each of the 160 receptors located on this grid. The radials are separated by 22.5-degree intervals beginning with 0.0 degrees and proceeding clockwise to 337.5 degrees. The 10 downwind distances for each radial are 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, 20.0, 30.0, 40.0, and 50.0 kilometers. The center of the receptor grid for each plant is assumed to be the plant center. Concentrations at other points were calculated by using a log-linear scheme as illustrated in Figure C-1.

C.3.1.2 Expansion of Analysis Area

At proposal, exposure and risk were estimated for people residing within 20 kilometers of the smelter. Some commenters pointed out that since people beyond 20 kilometers are exposed to some level of arsenic due to a source's emissions, EPA's proposal analysis underestimates the total exposure and risk. EPA agreed with the commenters and expanded its analysis out to 50 kilometers. When applying air dispersion models, the EPA's modeling guidelines recommend that, because of the increasing uncertainty of estimates with distance from the modeled source and because of the paucity of validation studies at larger distances, the impact may extend out to 50 kilometers, but the analysis should generally be limited to this distance from the source.[4] Such site-specific factors as terrain features (complex or flat), the objectives of the modeling exercise, and distance to which the model has been validated will determine the appropriate distance (whether greater than or less than the guideline distance) for which the Agency should apply the model.

C.3.1.3 Methodology for Reviewing Pollutant Concentrations

Before making HEM computer runs, EPA reviewed small-scale U.S. Geological Survey topographical maps (scale 1:24000) to verify locational data for each arsenic source. Plants were given accurate latitude and longitude values which were then incorporated into the HEM program.

After completing the HEM runs, nearby monitoring sites with ambient air quality data were identified by a computer search of EPA's National Aerometric Data Bank (NADB) (Table C.3). At some sites, data collected over several years along with annual averages (based on different numbers of sample sizes for the years monitored) for each year were available. In these instances, weighted multi-year averages were calculated to provide an overall mean for each monitoring site. For purposes of annual mean calculations, values measured below minimum detection limits were considered by EPA to be equal to one half the detection limit. These ambient arsenic data were then compared to HEM predicted values in order to gauge the accuracy of the air dispersion models' estimates. As noted above, HEM predicted values were based on cencentrations at 160 polar coordinate receptor grid points consisting of 10 downwind distances located along each of 16 radials which represented wind directions. Because the actual monitoring site locations idenitifed in the NADB retrieval usually did not correspond to exact grid point locations, a log-linear interpolation scheme (Figure C-1) was used to calculate an estimated concentration at the site.

C.3.1.3.1 Use of Ambient Data

Certain criteria were considered in review of ambient levels. Mean concentration values derived from sample sizes of less than 25 data points were disregarded. When reviewing the available monitoring data, it appeared that monitors situated at distances greater than 15 km from the arsenic source were considered too far from the source to guage air dispersion results without interference from other arsenic sources. Furthermore, at distances greater than 15 km from the sources, plant impacts were often predicted to be significantly lower than minimum detection limits. These data were not incorporated in the analyses. A third consideration in reviewing ambient data concerned the percentage of monitored data which fell below minimum detection limits. Although some monitoring sites registered data with over 90% of the values above minimum detection levels, many had about half the data points or more below such levels and some had less than 10% above detectable levels. Instances where more than 50% of data were below MDL were disregarded. It should be noted that Table C.3 displays, in addition to company-collected data, all ambient monitoring data that were collected at sites within 15 kilometers of the source as identified by EPA's computer search although not all the data were used in the final analysis.

C.3.2 ASARCO-El Paso

Predicted (HEM) versus measured data were plotted (Figure C-2) and a least squares weighted linear regression analysis was run based on thirteen data points (see Table C.3). The least squares regression line (solid line) was determined on the basis of a comparison of National Aerometric Data Bank monitoring data (circumscribed dots) and ASARCO monitoring data (circumscribed Xs) with ambient concentrations predicted by the Human Exposure Model.

The reader should note that a perfect fit for the least squares regression analysis results in a line running through the origin at a 45° angle (dotted lines on Figures C-2 to C-3). This means that, if the HEM model predicts the measured data perfectly, then the data points would fall on the dotted line. In cases where the HEM model underpredicts concentrations, data points will be located above the 45° perfect fit line. Likewise, when the HEM model overpredicts concentrations, data points will be located below the perfect fit line. The regression line resulting from our comparison of predicted and monitored data runs nearly parallel to the perfect fit line but intersects the ordinate axis at a value of approximately 0.09 $\mu g/m^3$. This result is consistent with the expectation that air dispersion modeling would underpredict ambient concentrations. The air dispersion modeling did not consider other local sources of arsenic such as naturally-occurring arsenic in the windblown dust and reentrained arsenic particulate matter that had settled to the earth from past smelter emissions.

Table C.3
Arsenic Concentrations Near Select Primary Copper Smelters

Plant	# Obs.	Distance[1] (km)	Bearing	HEM Predicted[2] (μg/m³)	ISCLT/Valley Predicted (μg/m³)	NADB Measured[3] (μg/m³)	MDL[4] (μg/m³)	Percentile[5]
ASARCO- El Paso, TX	35	.2	314.9	0.770	1.20	0.935	0.02	<10
	13	2.2	105.1	0.051	0.042	0.105	0.02	10 *
	18	1.5	124.8	0.039	0.024	0.302	0.05	10< % <30*
	298	4.0	121.8	0.024	0.0112	0.133	0.05	50
	38	4.5	156.4	0.0062	0.0087	0.249	0.02	10< % <30
	31	4.6	126.1	0.020	0.0082	0.109	0.0055	10< % <30
	140	4.7	122.8	0.020	0.0082	0.168	0.05	50< % <70*
	50	4.7	122.8	0.020	0.0082	0.217	0.02	10< % <30
	43	4.9	82.4	0.024	0.0092	0.046	0.02	30< % <50
	51	8.1	101.8	0.0115	---	0.065	0.02	30< % <50
	19	10.2	320.4	0.0183	0.0050	0.090	0.05	30< % <50*
	41	10.9	94.8	0.0085	---	0.100	0.05	30< % <50
	258	11.6	105.4	0.0074	---	0.058	0.05	50< % <70*
	45	13.8	352.7	0.0133	0.0094	0.021	0.02	7-< % <90*
ASARCO-El Paso Company Data	456	1.7	22.5	0.083	0.129	0.08	---	---
	456	2.0	337.5	0.103	0.054	0.21	---	---
	456	2.2	135	0.042	0.0197	0.21	---	---
	456	2.2	90	0.057	0.042	0.11	---	---
	456	4.0	135	0.022	0.087	0.12	---	---
	456	5.1	315	0.041	0.0095	0.10	---	---

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* Indicates data point was disregarded - see Section C.3.1.3.1

[1] Distance from source to monitor (km)

[2] Concentration predicted by Human Exposure Model (HEM) - see Section 3.1

[3] The measured values are weighted averages. When the sampled arsenic concentrations were below the MDL, a value of 1/2 MDL was assumed for purposes of calculating the annual averages.

[4] Minimum Detection Limit

[5] Percentile indicates percentage of data falling below minimum detectable levels

Table C.3 (Continued)

Plant	# Obs.	Distance[1] (km)	Bearing	HEM Predicted[2] ($\mu g/m^3$)	ISCLT/Valley Predicted ($\mu g/m^3$)	NADB Measured[3] ($\mu g/m^3$)	MDL[4] ($\mu g/m^3$)	Percentile[5]
ASARCO-Hayden, AZ	270	1.0	247.3	0.088		0.077	0.02	50< % <70*
	244	3.8	306.2	0.200		0.092	0.02	10< % <30
ASARCO-Hayden, Company Data	456	0.8	270	0.220		0.14	--	--
	183	4.2	270	0.041		0.12	--	--
	456	4.3	315	0.210		0.20	--	--
Inspiration Copper-Miami, AZ	308	2.6	234	0.0033		0.013	0.02	90< % <95*
	207	3.2	206.3	0.0022		0.012	0.02	90< % <95*
	31	4.0	12.2	0.0103		0.013	0.02	>99*
Magma Copper-San Manuel, AZ	19	1.7	308.4	0.0136		0.014	0.02	90< % <95*
	1	3.2	247.6	0.0017		0.010	0.02	>99*
Phelps-Dodge-Ajo, AZ	325	1.6	359	0.0113		0.035	0.02	70< % <90*
Phelps-DOdge-Douglas, AZ	23	.9	24.1	0.031	0.070	0.014	0.02	90< % <95*
	251	2.4	6	0.028	0.028	0.024	0.02	70< % <90*
	94	4.4	81.5	0.017	0.0167	0.016	0.0055	30< % <50
	154	4.4	81.9	0.017	0.0167	0.019	0.02	70< % <90*
	197	14.4	283.5	0.0063	0.0099	0.011	0.02	95< % <99*
Phelps-Dodge, Morenci, AZ	30	1.8	102.8	0.0065		0.010	0.02	>99*
	291	5.9	203.7	0.00052		0.013	0.02	90< % <95*

---

[1] Distance from source to monitor (km)

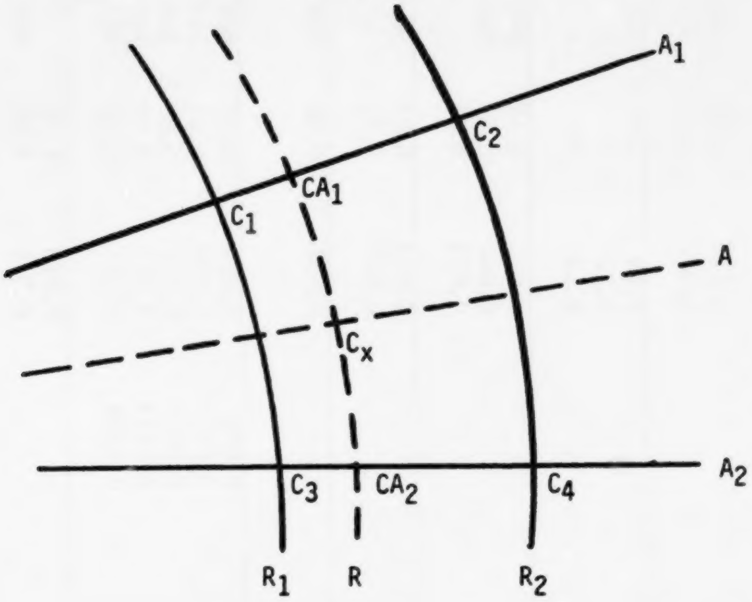
[2] Concentration predicted by Human Exposure Model (HEM) - see Section C.3.1

[3] The measured values are weighted averages. When the sampled arsenic concentrations were below the MDL, a value of 1/2 MDL was assumed for purposes of calculating the annual averages.

[4] Minimum Detection Limit

[5] Percentile indicates percentage of data falling below minimum detectable levels

Figure C-1 Group 2 BG/ED Interpolation



Given:

A - The angle in radians subtended clockwise about the source from due south to the BG/ED centroid;

A1 - The angle from due south to the radial line immediately counterclockwise of A, or passing through A if there is an exact match;

A2 - The angle from due south to the radial line immediately clockwise of A1 (A2 is 0 if it is due south);

R - The distance in km from the source to the BG/ED centroid;

R1 - The distance from the source to the largest circular arc of radius less than R;

R2 - The distance from the source to the smallest circular arc of radius greater than or equal to R;

C1 - The natural logarithm of the concentration value at (A1, R1);

C2 - The natural logarithm of the concentration value at (A1, R2);

C3 - The natural logarithm of the concentration value at (A2, R1);

C4 - The natural logarithm of the concentration value at (A2, R2);

then:

RTEMP - ln(R/R1)/ln(R2/R1);

ATEMP - (A-A1)/(A2-A1);

CA1 - exp(C1 + (C2-C1)xRTEMP);

CA2 - exp(C3 + (C4-C3)xRTEMP); and

CX - CA1 + (CA2-CA1)xATEMP,

where CX is the interpolated concentration at the BG/ED centroid.

C.3.3 ASARCO-Hayden

Predicted (HEM) versus measured data were plotted (Figure C-3) and a least squares weighted linear regression analysis was computed based on a number of data points. The least squares regression line (solid line), calculated on the basis of NADB monitoring data and ASARCO's own monitoring data (circumscribed Xs), was plotted along with the data points themselves (circumscribed dots). As with the ASARCO-El Paso case, a second regression analysis was run without incorporating ASARCO monitored data. The results remained essentially the same.

C.3.4 Site-Specific Modeling

In its original risk assessment, EPA did not consider terrain effects or the effects of buoyancy of the fugitive emissions escaping from the furnace buildings. These emissions originate from various sources, including matte tapping, converter, and anode furnace operations. Because the fugitive emissions are released from openings in the building roofs, the emissions can be entrained in the building wake on the leeward side of the furnace buildings. At the same time, since the emissions are warmer than ambient air, they tend to rise. Consequently, after experiencing downwash initially, the plume may lift-off, thus lowering ground-level concentrations downwind. However, this effect can be offset in the presence of rising terrain.

Since the combined effect of terrain, downwash, and buoyancy on airborne arsenic concentrations was unclear, additional dispersion analyses were carried out for two primary copper smelters. The smelters examined were those located at El Paso, Texas and Douglas, Arizona. For the El Paso analysis, the Industrial Source Complex Long Term (ISCLT) model and the Valley model were used in conjunction with a joint frequency distribution of wind speed, stability class, and wind direction. The frequency distribution was derived from on-site measurements of wind speed and wind direction and concurrent cloud cover and ceiling height observations made at El Paso International Airport. The Valley model was used for receptors above the top of the furnace buildings, while the ISCLT model was used at all other receptors. The Valley model allows the plume to intersect terrain features under stable atmospheric conditions, resulting in high concentrations. For receptors well above the plume centerline, the impact of the plume is gradually reduced. In order to better assess the impact of buoyancy on the dispersion of the furnace building emissions, a modified plume rise treatment similar to that in the Buoyant Line and Point Source (BLP) model was used. In this treatment, the building emissions are regarded as a buoyant line source having a finite length and width and subject to an initial dilution associated with downwash. However, because estimates of the buoyancy of the emissions are highly uncertain, the analysis was repeated assuming no buoyancy and therefore no plume lift-off. Both analyses included an enhancement to the dispersion of the plume due to building downwash, an enhancement which is a part of the ISCLT model. The two sets of analyses were intended to bracket the expected impact of the furnace building emissions on airborne inorganic arsenic concentrations.

FIGURE C-2 Predicted Versus Measured Inorganic Arsenic Ambient Concentrations (ASARCO - El Paso, TX)

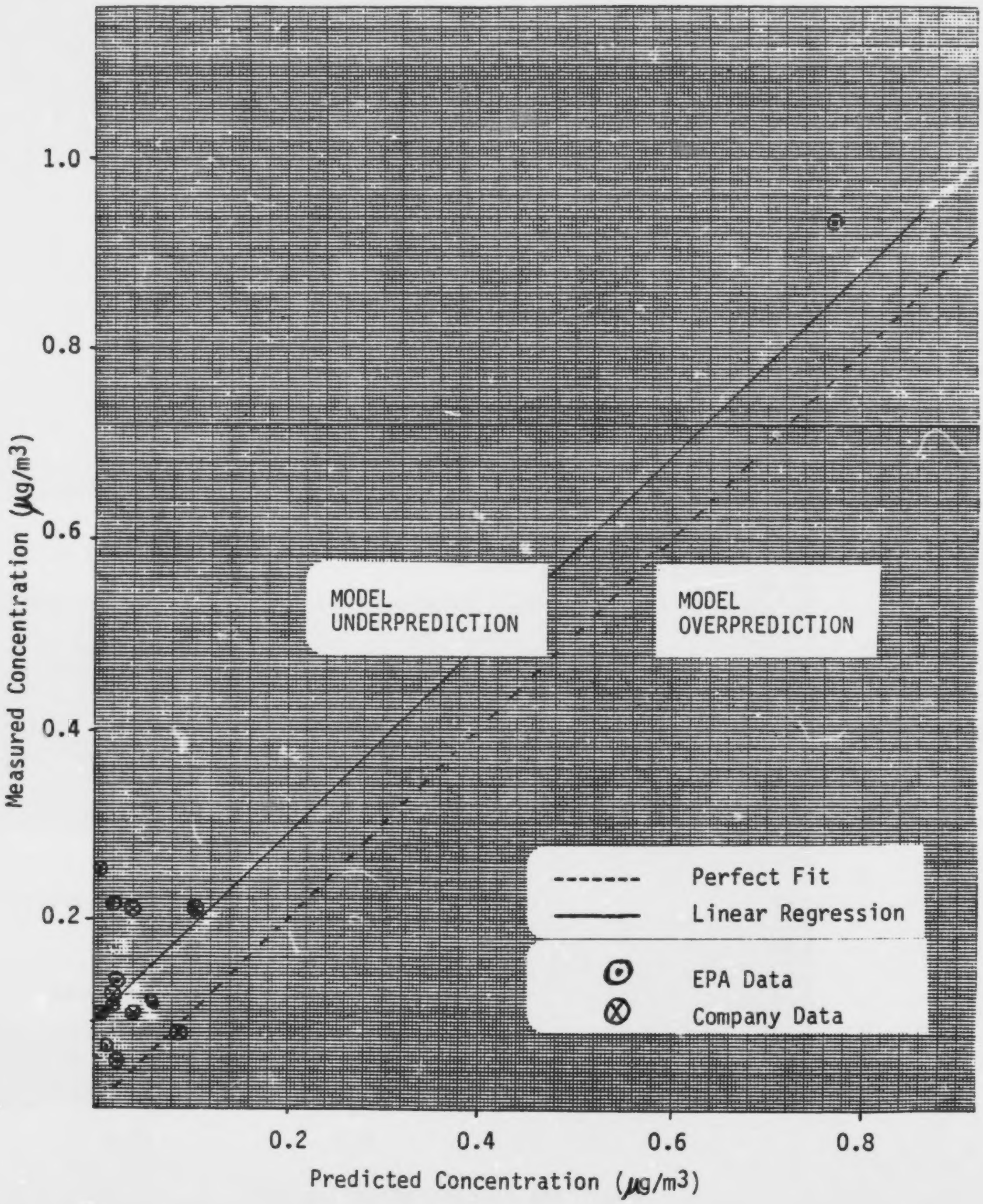
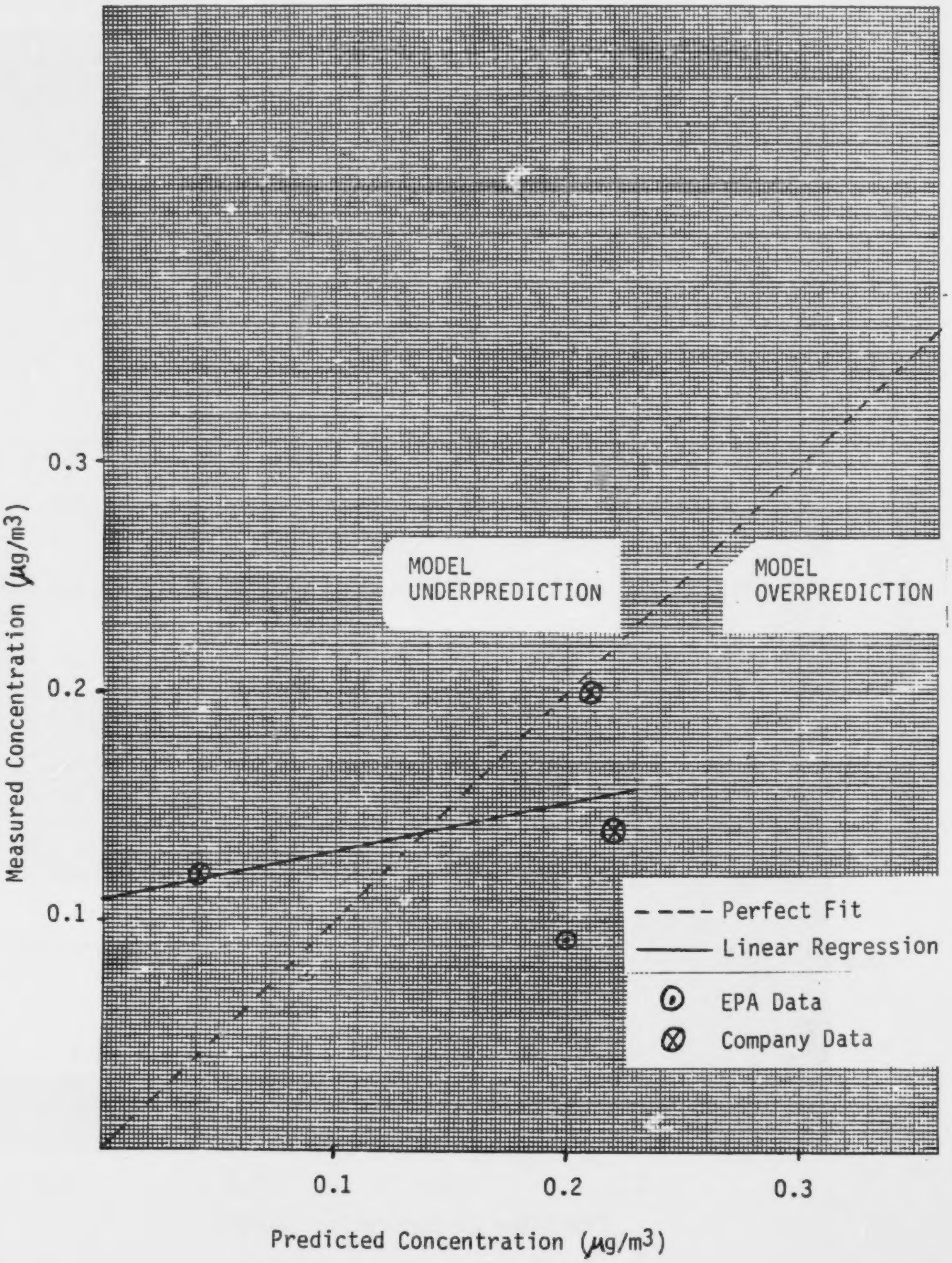


FIGURE C-3 Predicted Versus Measured Inorganic Arsenic Ambient Concentrations

(ASARCO - Hayden, AZ)



Predicted (ISCLT/Valley) versus measured data were plotted (Figure C-4) and a least squares weighted linear regression analysis was run based on thirteen data points (see Table C.3). The least squares regression line was determined on the basis of a comparison of National Aerometric Data Bank monitoring data and ASARCO monitoring data with ambient concentrations predicted by the ISCLT/Valley model.

Results obtained from HEM and the two site-specific analyses for El Paso can be seen in Tables C.4 - C.6. Table C.4 outlines arsenic concentrations estimated by the Human Exposure Model (HEM) to occur at 16 wind directions and eight distances downwind from the El Paso plant center. Table C.5 shows corresponding values based on the standard ISCLT and Valley models run in conjunction with a joint frequency distribution of wind speed, stability class, and wind direction. Table C.6 shows values based on the ISCLT and Valley models used in conjunction with modified plume rise treatment. Agreement between the HEM and ISCLT/Valley calculations is fairly good with differences rarely exceeding a factor of 2 or 3. In regions of higher concentrations, both models give nearly equal results. The HEM tends to overpredict slightly in regions of lower concentration.

A nearly identical approach was taken for the Douglas, Arizona analysis. The ISCLT and Valley models were used in conjunction with a frequency distribution of wind speed, stability class, and wind direction derived from surface weather observations at Bisbee/Douglas International Airport. Two sets of analyses were conducted, one including the effect of plume buoyancy associated with fugitive emissions from the furnace building and the other not. As before, the two sets of analyses were intended to bracket the expected impact of these emissions on airborne inorganic arsenic concentrations.

Results obtained from HEM and the two site-specific analyses for Douglas can be seen in Tables C.7 - C.9. Table C.7 outlines arsenic concentrations estimated by the HEM to occur at 128 points (see above) around the Douglas smelter. Table C.8 shows corresponding values based on the standard ISCLT and Valley models run in conjunction with a joint frequency distribution of wind speed, stability class, and wind direction. Table C.9 shows values based on the ISCLT and Valley models used in conjunction with modified plume rise treatment. In general, the HEM tends to underpredict slightly when compared to the ISCLT/Valley model but the differences between values estimated to occur around the smelter rarely exceed a factor of 2 or 3.

At the remaining copper smelters where site-specific air dispersion analysis was not performed, the standard analysis (HEM) as described in section C.3.1 was used. Comparison of concentration profiles that were predicted by HEM and the ISCLT/Valley models and the comparison of the two modeling results to measured ambient concentrations indicate that the standard HEM analysis produces similar results to the sophisticated air dispersion models. Since site-specific analysis is resource intensive and was not producing significantly different results from the standard analysis, acceptable risk estimates for the remaining smelters were produced by the HEM analysis.

FIGURE C-4 Predicted Versus Measured Inorganic Arsenic Ambient Concentrations

(ASARCO - El Paso, TX)

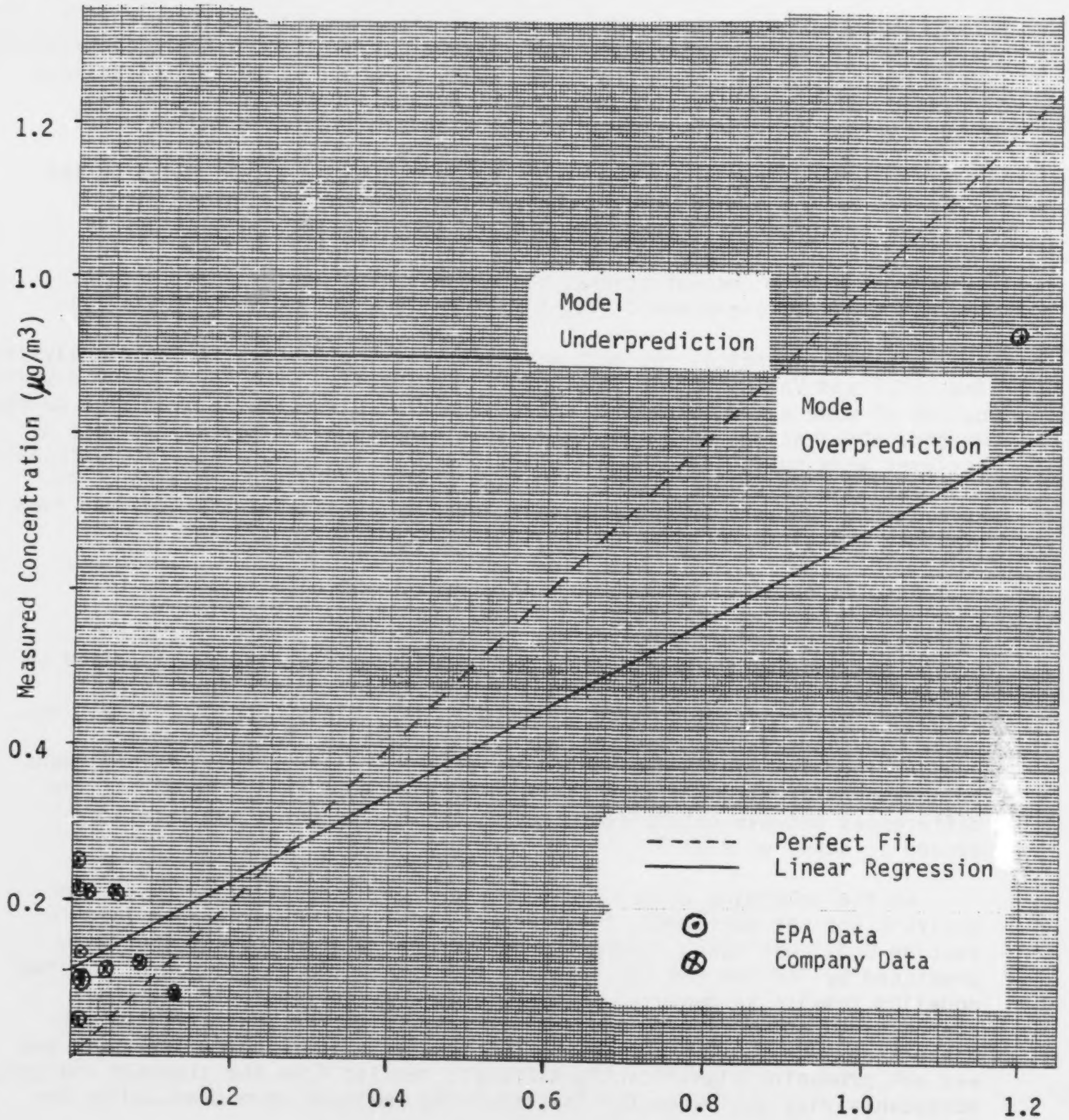


Table C.4

Estimated Arsenic Concentrations In the Vicinity of A Primary Copper Smelter in El Paso, TX Based on Human Exposure Model (HEM) Calculations

WIND	DOWNWIND DISTANCE (KM)							
DIRECTION	.500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	2.5584-001	1.3675-001	6.8637-002	1.1596-002	5.3756-003	3.4566-003	2.5344-003	1.9952-003
SSW	2.6623-001	1.4265-001	7.0319-002	1.1811-002	5.4566-003	3.5077-003	2.5718-003	2.0250-003
SW	2.6174-001	1.4336-001	7.2372-002	1.2640-002	5.8955-003	3.8079-003	2.8027-003	2.2136-003
WSW	1.6592-001	1.0139-001	5.0921-002	8.8539-003	4.1253-003	2.6612-003	1.9566-003	1.5440-003
W	1.9137-001	1.0155-001	5.0016-002	8.4661-003	3.9096-003	2.5131-003	1.8395-003	1.4480-003
WNW	1.9566-001	1.0215-001	4.9799-002	8.2971-003	3.8118-003	2.4423-003	1.7878-003	1.4063-003
NW	2.2942-001	1.2016-001	5.9027-002	1.0001-002	4.6098-003	2.9613-003	2.1726-003	1.7122-003
NNW	2.3212-001	1.1775-001	5.6142-002	9.1254-003	4.1515-003	2.6482-003	1.9333-003	1.5180-003
N	2.5990-001	1.3225-001	6.3510-002	1.0411-002	4.7484-003	3.3346-003	2.2187-003	1.7440-003
NNE	1.6085-001	8.0217-002	3.7650-002	6.0580-003	2.7400-003	1.7428-003	1.2701-003	9.9601-004
NE	1.9935-001	1.0147-001	4.6297-002	7.7467-003	3.5214-003	2.2416-003	1.6329-003	1.2795-003
ENE	1.7544-001	8.7275-002	3.9617-002	5.9209-003	2.6373-003	1.6474-003	1.1807-003	9.1258-004
E	1.4795-001	7.4144-002	3.4029-002	5.1796-003	2.3264-003	1.4553-003	1.0465-003	8.1110-004
ESE	1.2366-001	6.2036-002	2.9033-002	4.4274-003	1.9914-003	1.2517-003	9.0137-004	6.9932-004
SE	9.6975-002	5.2178-002	2.5475-002	4.2731-003	1.9691-003	1.2616-003	9.2309-004	7.2572-004
SSE	4.2705-002	1.9425-002	6.1062-003	1.0247-003	4.2066-004	2.5958-004	1.8322-004	1.4010-004

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Table C.5

Estimated Arsenic Concentrations In the Vicinity of A Primary Copper Smelter in El Paso, TX Based on Standard Industrial Source Complex Long Term (ISCLT) and Valley Model Calculations

DIR	DISTANCE							
	.500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	1.3696+000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SSW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
WSW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
W	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
WNW	2.2913-001	1.0672-001	3.7436-002	3.6367-003	1.4593-003	8.4420-004	6.0108-004	4.4910-004
NW	3.2348-001	1.1701-001	5.3994-002	4.7339-003	2.3725-003	1.3106-003	9.1335-004	7.0576-004
NNW	5.1153-001	2.0196-001	6.9290-002	9.3520-003	3.7378-003	2.3535-003	1.6073-003	1.2240-003
N	6.7958-001	3.3511-001	1.7364-001	1.5940-002	7.1978-003	4.3657-003	3.2688-003	4.0093-003
NNE	4.9540-001	2.6372-001	1.2233-001	1.1521-002	4.3574-003	2.7225-003	1.9570-003	1.5017-003
NE	2.5638-001	1.3319-001	5.9679-002	5.5473-003	2.4212-003	1.3860-003	9.3991-004	6.9026-004
ENE	1.7123-001	8.9380-002	2.8795-002	2.5508-003	1.1209-003	6.4472-004	6.1953-004	4.2587-004
E	2.0266-001	1.2970-001	4.7947-002	4.2524-003	2.0020-003	1.1885-003	8.1177-004	1.2001-003
ESE	3.2037-001	1.5824-001	5.3255-002	.0000	1.8504-003	1.2821-003	9.5686-004	7.2659-004
SE	4.8097-001	1.7144-001	2.7624-002	.0000	.0000	.0000	5.2595-004	3.9585-004
SSE	9.2361-001	.0000	.0000	.0000	.0000	.0000	.0000	.0000

Table C.6

Estimated Arsenic Concentrations In the Vicinity of A Primary Copper Smelter in El Paso, TX Based on Building Downwash Standard Industrial Source Complex Long Term (ISCLT) and Valley Model Calculations

DIR	DISTANCE							
	.500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	1.0361+000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SSW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
WSW	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
W	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
WNW	1.8929-001	7.6897-002	3.5990-002	3.3636-003	1.4603-003	8.4517-004	6.0185-004	4.4973-004
NW	2.6283-001	9.2378-002	4.2272-002	3.9236-003	1.9444-003	1.3117-003	9.1437-004	7.0662-004
NNW	3.9663-001	1.5698-001	5.4587-002	8.7891-003	3.6501-003	2.3551-003	1.6094-003	1.2257-003
N	4.8662-001	2.2272-001	8.7069-002	1.5963-002	7.2227-003	4.3829-003	3.2814-003	4.0083-003
NNE	3.3709-001	1.5198-001	1.2236-001	1.1514-002	4.3725-003	2.7315-003	1.9632-003	1.5065-003
NE	2.3407-001	7.9835-002	5.6951-002	5.5649-003	2.4276-003	1.3896-003	9.4234-004	6.9205-004
ENE	1.4995-001	8.9504-002	2.5785-002	1.7344-003	1.1227-003	6.4581-004	6.2029-004	4.2044-004
E	1.5220-001	1.2063-001	4.7871-002	3.1524-003	2.0046-003	1.1901-003	8.1267-004	1.2009-003
ESE	2.1584-001	1.3628-001	4.9905-002	.0000	1.6143-003	1.2501-003	9.5799-004	7.2745-004
SE	3.5290-001	1.3791-001	2.2452-002	.0000	.0000	.0000	4.7482-004	3.6435-004
SSE	6.7680-001	.0000	.0000	.0000	.0000	.0000	.0000	.0000

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Table C.7

Estimated Arsenic Concentrations In the Vicinity of A Primary Copper Smelter in Douglas, AZ Based on Human Exposure Model Calculations

WIND	DOWNWIND DISTANCE (KM)							
DIRECTION	.500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	1.0771-001	7.6211-002	5.1605-002	1.3116-002	6.3110-003	4.1026-003	3.0264-003	2.3926-003
SSW	5.7611-002	4.4546-002	3.1654-002	8.1397-003	3.9578-003	2.5880-003	1.9166-003	1.5196-003
SW	8.8792-002	6.8457-002	4.8868-002	1.2509-002	6.0584-003	3.9577-003	2.9301-003	2.3232-003
WSW	3.9851-002	3.1284-002	2.2496-002	5.7644-003	2.7915-003	1.8178-003	1.3446-003	1.0641-003
W	1.0686-001	8.1290-002	5.7376-002	1.4710-002	7.1008-003	4.6169-003	3.4046-003	2.6905-003
WNW	4.6565-002	3.2657-002	2.2205-002	5.6201-003	2.6679-003	1.7185-003	1.2597-003	9.9119-004
NW	1.2095-001	7.4679-002	4.7674-002	1.1594-002	5.3287-003	3.3868-003	2.4644-003	1.9300-003
NNW	8.1722-002	4.4898-002	2.6735-002	6.2886-003	2.7532-003	1.6989-003	1.2115-003	9.3461-004
N	1.2683-001	6.6257-002	3.8138-002	8.9282-003	3.8144-003	2.3131-003	1.6283-003	1.2437-003
NNE	5.0423-002	2.6838-002	4.5592-002	3.7767-003	1.6406-003	1.0002-003	7.0567-004	5.3958-004
NE	9.0796-002	5.0049-002	2.9649-002	7.2609-003	3.2005-003	1.9678-003	1.3961-003	1.0717-003
ENE	6.2097-002	3.4770-002	2.0726-002	5.2116-003	2.3049-003	1.4088-003	9.9255-004	7.5693-004
E	1.0335-001	5.8642-002	3.5395-002	8.6871-003	3.8817-003	2.4082-003	1.7196-003	1.3267-003
ESE	5.0243-002	2.7066-002	4.6074-002	3.8610-003	1.6885-003	1.0417-003	7.4279-004	5.7316-004
SE	1.1275-001	6.5694-002	4.0612-002	1.0020-002	4.5656-003	2.8820-003	2.0864-003	1.6275-003
SSE	5.7584-002	3.6174-002	2.2918-002	5.7839-003	2.7166-003	1.7387-003	1.2689-003	9.9520-004

Table C.8

Estimated Arsenic Concentrations In the
Vicinity of A Primary Copper Smelter in
Douglas, AZ Based on Standard Industrial
Source Complex Long Term (ISCLT) and Valley
Model Calculations

DIR	DISTANCE .500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	1.5059-001	1.0169-001	.0000	.0000	.0000	.0000	.0000	.0000
SSW	1.5266-001	9.6417-002	.0000	.0000	.0000	.0000	.0000	.0000
SW	1.7989-001	1.0517-001	3.3113-002	.0000	.0000	.0000	.0000	.0000
WSW	1.3231-001	8.6299-002	4.6349-002	.0000	.0000	.0000	.0000	.0000
W	1.7565-001	1.3921-001	9.4608-002	1.9764-002	1.2597-002	2.4763-002	1.2613-002	3.6470-003
WNW	2.1093-001	1.1441-001	5.9550-002	9.6757-003	3.7839-003	1.1584-002	7.5110-003	1.7227-003
NW	1.6036-001	9.6885-002	6.5262-002	1.0063-002	6.1038-003	4.0737-003	1.0106-002	1.3286-002
NNW	2.2160-001	1.0987-001	4.4630-002	7.0586-003	3.7205-003	2.3245-003	1.8495-003	3.2182-003
N	2.3145-001	9.5531-002	4.3921-002	1.0561-002	4.4926-003	3.1446-003	3.4796-003	6.5360-003
NNE	3.2338-001	9.6591-002	2.9094-002	5.3765-003	3.7737-003	6.2693-003	3.6073-003	5.8036-004
NE	3.6571-001	8.9791-002	3.5512-002	7.7064-003	6.8434-003	5.5924-003	5.1025-003	4.1997-003
ENE	4.1406-001	8.6626-002	3.4060-002	6.0696-003	5.5560-003	1.9784-003	1.5204-003	2.1686-003
E	2.9527-001	9.1136-002	4.2665-002	9.8433-003	9.5540-003	2.1357-003	9.6918-003	4.6587-003
ESE	3.2529-001	9.0805-002	3.1202-002	.0000	.0000	.0000	.0000	.0000
SE	2.4671-001	9.4296-002	2.5825-002	.0000	.0000	.0000	.0000	.0000
SSE	2.5420-001	9.7772-002	.0000	.0000	.0000	.0000	.0000	.0000

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Table C.9

Estimated Arsenic Concentrations In the Vicinity of A Primary Copper Smelter in Douglas, AZ Based on Building Downwash Industrial Source Complex Long Term (ISCLT) and Valley Model Calculations

DIR	DISTANCE .500	1.000	2.000	10.000	20.000	30.000	40.000	50.000
S	1.2630-001	9.3713-002	.0000	.0000	.0000	.0000	.0000	.0000
SSW	1.2727-001	6.7663-002	.0000	.0000	.0000	.0000	.0000	.0000
SW	1.3706-001	7.9387-002	2.1963-002	.0000	.0000	.0000	.0000	.0000
WSW	6.1732-002	4.6653-002	2.7036-002	.0000	.0000	.0000	.0000	.0000
W	9.6156-002	6.6233-002	4.9203-002	1.9862-002	1.2638-002	2.4728-002	1.2630-002	3.6603-003
WNW	1.1280-001	5.6736-002	3.0806-002	9.6995-003	3.7931-003	1.1585-002	7.5109-003	1.7254-003
NW	9.2418-002	6.5397-002	4.3993-002	1.2284-002	6.1089-003	4.0785-003	1.0109-002	1.3291-002
NNW	1.6309-001	7.8353-002	3.2649-002	6.2247-003	3.7239-003	2.3264-003	1.8509-003	3.2192-003
N	1.3961-001	6.6653-002	3.4689-002	1.0567-002	4.4957-003	3.1463-003	3.4609-003	6.5370-003
NNE	1.6894-001	5.9275-002	2.2772-002	5.3601-003	3.7752-003	6.2702-003	3.6077-003	5.8004-004
NE	1.7721-001	6.1148-002	2.6674-002	7.7127-003	6.8446-003	5.5933-003	5.1038-003	4.2036-003
ENE	1.6074-001	5.3775-002	2.3767-002	6.0767-003	5.5592-003	1.9802-003	1.5218-003	2.1690-003
E	1.2179-001	5.0279-002	2.6159-002	9.8717-003	9.5666-003	1.8609-003	9.6972-003	4.6586-003
ESE	2.0043-001	6.4350-002	2.2619-002	.0000	.0000	.0000	.0000	.0000
SE	1.6254-001	6.4061-002	1.9793-002	.0000	.0000	.0000	.0000	.0000
SSE	1.9964-001	9.1438-002	.0000	.0000	.0000	.0000	.0000	.0000

C.3.5 The People Living Near A Source

To estimate the number and distribution of people residing within 50 kilometers of the smelter, the HEM model uses the 1980 Master Area Reference File (MARF) from the U.S. Bureau of Census. This data base consists of enumeration district/block group (ED/BG) values. MARF contains the population centroid coordinates (latitude and longitude) and the 1980 population of each ED/BG (approximately 300,000) in the United States (50 States plus the District of Columbia). HEM identifies the population around each plant, by using the geographical coordinates of the plant, and identifies, selects, and stores for later use those ED/BGs with coordinates falling within 50 kilometers of plant center.

For each of the fourteen smelter locations, a detailed check was made to determine whether the exposed population as predicted by the HEM was located accurately. A review of U.S. Geological Survey maps revealed some discrepancies at ten of the smelter sites. In these cases, the model placed the populations near sites which had high ambient arsenic concentrations but which clearly did not contain settlements. Such sites included tailings ponds, railroad tracks and locations in rugged terrain. For the purpose of risk and incidence estimation the distance and bearing of actual exposed populations were revised (Table C.10).

For two smelter sites in El Paso, TX, and Douglas, AZ, the maximum concentrations to which individuals are exposed were derived originally from HEM estimated values, as seen in Table C.10. To further refine calculation of exposure and risk, concentration estimates at those two sites were modified using values from the ISCLT/Valley models used in the site-specific analyses described in Section C.3.1.3.1. These concentration estimates are summarized in Table C.11.

C.3.6 Exposure[5]

The Human Exposure Model (HEM) uses the estimated ground level concentrations of a pollutant together with population data to calculate public exposure. For each of 160 receptors located around a plant, the concentration of the pollutant and the number of people estimated by the HEM to be exposed to that particular concentration are identified. The HEM multiplies these two numbers to produce exposure estimates and sums these products for each plant.

A two-level scheme has been adopted in order to pair concentrations and populations prior to the computation of exposure. The two-level approach is used because the concentrations are defined on a radius-azimuth (polar) grid pattern with non-uniform spacing. At small radii, the grid cells are usually smaller than ED/BG's; at large radii, the grid cells are usually larger than ED/BG's. The area surrounding the source is divided into two regions, and each ED/BG is classified by the region in which its centroid lies. Population exposure is calculated differently for the ED/BG's located within each region. For ED/BG centroids located between 0.2 km and 3.5 km from the emission source, populations are divided between neighboring concentration grid points. There are 64 (4 x 16) polar grid points within this range. Each grid point has a polar sector defined by two concentric arcs and two wind direction radials. Each of these grid points and respective concentrations are assigned to the nearest ED/BG centroid identified from 1980 U.S. Census Bureau data. Each ED/BG can be paired with one or many concentration points. The population associated with the ED/BG centroid is then divided among all concentration grid points assigned to it. The land area within each polar sector is considered in the apportionment.

For population centroids between 3.5 km and 50 km from the source, a concentration grid cell, the area approximating a rectangular shape bounded by four receptors, is much larger than the area of a typical ED/BG. Since there is an approximate linear relationship between the logarithm of concentration and the logarithm of distance for receptors more than 2 km from the source, the entire population of the ED/BG is assumed to be exposed to the concentration that is logarithmically interpolated radially and arithmetically interpolated azimuthally from the four receptors bounding the grid cell. Concentration estimates for 96 (6 x 16) grid cell receptors at 5.0, 10.0, 20.0, 30.0, 40.0, and 50.0 km from the source along each of 16 wind directions are used as reference points for this interpolation.

In summary, two approaches are used to arrive at coincident concentration/population data points. For the 64 concentration points within 3.5 km of the source, the pairing occurs at the polar grid points using an apportionment of ED/BG population by land area. For the remaining portions of the grid, pairing occurs at the ED/BG centroids themselves through the use of log-log and linear interpolation. (For a more detailed discussion of the model used to estimate exposure, see Reference 5.)

C.3.7 Public Exposure to Inorganic Arsenic Emissions from Low-Arsenic Primary Copper Smelters

C.3.7.1 Source Data

Fourteen copper smelters are included in the analysis. Table C.12 lists the names and addresses of the plants considered, and Tables C.13-C.15 list the plant data used as input to the Human Exposure Model (HEM) for baseline, converter controls and converter plus matte and slag tapping controls scenarios.

C.3.7.2 Exposure Data

Table C.16 lists, on a plant-by-plant basis, the total number of people encompassed by the exposure analysis and the total exposure. Total exposure is the sum of the products of number of people times the ambient air concentration to which they are exposed, as calculated by HEM. Table C.17 sums, for the entire source category (14 plants), the numbers of people exposed to various ambient concentrations, as calculated by HEM. (Source-by-source exposure results are provided in the EPA docket numbered A-80-40.)

TABLE C.10 REVISIONS OF HEM PREDICTED MAXIMUM CONCENTRATIONS TO WHICH INDIVIDUALS ARE EXPOSED[1]

	Baseline			BAT Converter Controls		BAT Converter & Matte & Slag Tapping Controls		Revised Populatio Location	
Source	Conc	# of People Exposed	Revised Conc	Conc	Revised Conc	Conc	Revised Conc	Distance (km) from Source	Directio
ASARCO-El Paso*** (a)	9.2×10^{-1}	<1	2.3×10^{-1}	7.6×10^{-1}	1.88×10^{-1}	7.6×10^{-1}	1.88×10^{-1}	1.0	N
(b)	5.4×10^{-1}	<1	1.32×10^{-1}	5.6×10^{-1}	1.28×10^{-1}	5.6×10^{-1}	1.28×10^{-1}		
ASARCO-Hayden	2.8	1	3.1×10^{-1}	2.5	2.8×10^{-1}	2.5	2.8×10^{-1}	0.3	SW
Kennecott-Hayden	4.0×10^{-1}	1	5.9×10^{-2}	7.6×10^{-2}	1.13×10^{-2}	7.2×10^{-2}	8.4×10^{-3}	0.3	SW
Kennecott-Hurley	4.5×10^{-2}	<1	2.9×10^{-2}	2.1×10^{-2}	1.09×10^{-2}	2.1×10^{-2}	1.08×10^{-2}	0.3	NW
Kennecott-McGill	9.6×10^{-1}	<1	1.03×10^{-1}	1.40×10^{-1}	1.48×10^{-2}	1.39×10^{-1}	1.39×10^{-2}	0.3	W
Kennecott-Garfield	1.44×10^{-2}	2	1.44×10^{-2}*	1.39×10^{-2}	1.39×10^{-2}*	1.38×10^{-2}	1.38×10^{-2}*	5.0*	NE*
Phelps-Dodge Morenci	7.5×10^{-2}	2	1.87×10^{-2}	2.7×10^{-2}	5.4×10^{-3}	2.7×10^{-2}	5.2×10^{-3}	2.0	NW
Phelps-Dodge Douglas****	2.8×10^{-1}	2	2.8×10^{-1}*	4.5×10^{-2}	4.5×10^{-2}*	4.5×10^{-2}	4.5×10^{-2}*	0.2*	N*
Phelps-Dodge Ajo	5.0×10^{-2}	6	5.0×10^{-2}*	3.9×10^{-2}	3.9×10^{-2}*	3.9×10^{-2}	3.9×10^{-2}*	--**	--**
Phelps-Dodge Hidalgo	1.22×10^{-3}	909	1.22×10^{-3}*	8.1×10^{-4}	8.1×10^{-4}*	8.1×10^{-4}	8.1×10^{-4}*	2.4*	
Copper Range White Pine	2.5×10^{-2}	<1	2.5×10^{-2}*	3.5×10^{-3}	3.5×10^{-3}*	3.4×10^{-3}	3.4×10^{-3}*	--**	--**
Magma-San Manuel	3.8×10^{-2}	<1	3.8×10^{-2}*	1.04×10^{-2}	1.04×10^{-2}*	1.02×10^{-2}	1.02×10^{-2}*	0.2*	NW*
Inspiration-Miami	1.65×10^{-1}	<1	4.5×10^{-2}	7.5×10^{-2}	2.2×10^{-2}	7.1×10^{-2}	2.2×10^{-2}	0.4	SSE
Tenn. Copper Copperhill	6.4×10^{-2}	<1	1.32×10^{-2}	1.08×10^{-2}	2.4×10^{-3}	1.05×10^{-2}	2.0×10^{-3}	0.5	SE

[1] Revisions are based on review of USGS maps for comparison of HEM predicted population locations versus actual residential sites.

* Unchanged--HEM results are considered accurate.

** The distance and direction at which persons are exposed to the maximum concentration varies under baseline, converter controls and converter plus matte and slag tapping controls scenarios.

*** Although EPA recognizes the potential Mexican population exposure, available data are insufficient to make HEM exposure/risk calculation. Crude estimates indicate that the maximum concentration that would occur in the Mexican population is approximately the same magnitude as reported in the above table.

**** Although EPA recognizes the potential Mexican population exposure, available data are insufficient to make HEM exposure/risk calculation. Crude estimates indicate that the maximum concentration that would occur in the Mexican population is smaller than reported in the above table.

Table C.11

Predicted Maximum Concentration to Which Individuals Are Exposed at Two Primary Copper Smelter Sites Based on ISCLT[1] Site-Specific Modeling

	Baseline			BAT Converter Controls		Population Location	
Source	Conc	# Of People Exposed	Revised Conc[2]	Conc	Revised Conc[2]	Distance (km) From Source	Direction
ASARCO-El Paso	2.7	<1	2.2×10^{-1}	2.7	2.1×10^{-1}	1.0	N
Phelps-Dodge-Douglas	1.93×10^{-2}	862	---	1.64×10^{-2}	---	0.2	N

---

[1] Industrial Source Complex Long Term (Sensitivity) (See Section C.3.1.3.1)

[2] Revisions are based on review of USGS maps for comparison of ISCLT predicted population locations versus actual residential sites.

TABLE C.12

IDENTIFICATION OF LOW-ARSENIC PRIMARY COPPER SMELTERS

Plant Number Code	Plant Name and Address
1	ASARCO, Inc. El Paso, TX
2	ASARCO, Inc. Hayden, AZ
3	Kennecott Corp. Hayden, AZ
4	Kennecott Corp. Hurley, NM
5	Kennecott Corp. McGill, NV
6	Kennecott Corp. Garfield, UT
7	Phelps-Dodge Corp. Morenci, AZ
8	Phelps-Dodge Corp. Douglas, AZ
9	Phelps-Dodge Cor. Ajo, AZ
10	Phelps-Dodge Corp. Hidalgo, NM
11	Copper Range Co. White Pine, MI
12	Magma Copper San Manuel, AZ
13	Inspiration Consolidated Copper Co. Miami, AZ
14	Tennessee Chemical Co., Copperhill, TN

TABLE C.13. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BASELINE CONTROLS)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity m/sec	Emission Point Gas Temp. (°K)	Emission Point Type
ASARCO-El Paso (a)	31-46-54 106-31-23	15,655	252	4.9	3,606	20.4	366	Main Stack
		275	31	1.7	84	14.8	339	Converter/AP Stack
		310	40	2.7	110	7.4	337	Roaster/AP Stack
		10,965	30.5	---	3,720	0.8	320	Converter Building Fugitives
		710	0	---	---	---	298	Furnace Building Fugitives
		1,805	0	---	---	---	298	Misc. Fugitives
ASARCO-El Paso (b)	31-46-54 106-31-23	13,233	252	4.9	3,606	20.4	366	Main Stack
		281	31	1.7	84	14.8	339	Converter/AP Stack
		315	40	2.7	110	7.4	337	Roaster/AP Stack
		4,336	30.5	---	3,720	0.1	320	Converter/Building Fugitives
		107	0	---	---	---	298	Furnace Building Fugitives
		1,829	0	---	---	---	298	Misc. Fugitives
ASARCO-Hayden	33-00-30 110-46-33	2,210	305	5.2	6,300	12.8	339	Main Stack
		23,820	30.5	---	4,200	0.8	320	Converter Building Fugitives
		845	0	---	---	---	298	Furnace Building Fugitives
		3,270	0	---	---	---	298	Misc. Fugitives
Kennecott-Hayden	33-00-41 110-46-46	27,350	183	5.2	1,685	5.2	533	Furnace Stack
		40	30.5	2.4	84	10.4	352	Roaster/Converter/AP Stack
		6,620	30.5	---	4,650	0.8	320	Converter Building Fugitives
		835	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		95	0	---	---	---	298	Furnace Building Fugitives
		35	0	---	---	---	298	Misc. Fugitives
Kennecott-Hurley	32-41-56 108-07-19	140	190.5	10.0	1,750	3.8	339	Main Stack
		610	30.5	---	6,300	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.13. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BASELINE CONTROLS) (Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m²)	Emission Point Gas Exit Velocity m/sec	Emission Point Gas Temp. (°K)	Emission Point Type
Kennecott-McGill	39-24-33	102,340	229	4.7	2,725	20.4	422	Main Stack
	114-46-12	10,835	30.5	---	3,140	0.8	320	Converter Building Fugitives
		315	30.5	1.5	1,300	20.3	298	Captured Furnace Fugitives
		35	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Kennecott-Garfield	40-43-15	16,095	366	7.3	9,140	11.3	339	Main Stack
	112-11-53	13,315	30.5	---	4,800	0.8	320	Converter Building Fugitives
		205	0	---	---	---	298	Furnace Building Fugitives
		2,410	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Morenci	33-03-32	1,230	184	9.1	2,200	0.8	352	Reverb/AP Stack
	109-20-18	750	184	9.1	2,200	4.8	352	Converter/AP Stack
		1,435	30.5	---	11,200	0.8	320	Converter Building Fugitives
		25	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Douglas	31-20-38	19,445	166	6.7	1,685	10.3	480	Main Stack
	109-35-11	19,445	172	5.5	1,770	7.6	464	Converter Stack
		4,447	30.5	---	3,490	0.8	320	Converter Building Fugitives
		19	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Ajo	32-22-00	13,425	110	4.6	846	5.0	352	Main Stack
	112-51-18	540	30.5	---	3,720	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives

TABLE C.13. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS
(ASSUMING BASELINE CONTROLS)
(Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity m/sec	Emission Point Gas Temp. (°K)	Emission Point Type
Phelps Dodge Hidalgo	31-45-11 108-31-18	325	61	2.3	325	4.1	352	AP Stack
		100	183	5.5	2,000	6.6	401	Slag Furnace Stack
		240	30.5	---	3,600	0.8	320	Converter Building Fugitives
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Copper Range-White Pine	46-46-06 089-33-18	2,375	154	4.6	1,295	4.6	494	Main Stack
		480	30.5	---	3,255	0.8	320	Converter Building Fugitives
		50	30.5	1.5	3,800	20.3	298	Captured Furnace Fugitives
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Magma-San Manuel	32-36-57 110-37-22	10,920	155	6.4	2,100	5.9	519	Furnace Stack
		15	76	3.0	400	6.2	325	Converter/AP#1 Stack
		15	76	3.0	400	6.2	325	Converter/AP#2 Stack
		605	30.5	---	4,200	0.8	320	Converter Building Fugitives
		75	30.5	1.5	5,250	20.3	298	Captured Furnace Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Inspiration-Miami	33-24-43 110-51-00	390	61	3.1	325	7.1	325	Furnace/Converter/ AP Stack
		2,625	30.5	---	6,000	0.8	320	Converter Building Fugitives
		730	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		70	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.13. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BASELINE CONTROLS) (Concluded)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity m/sec	Emission Point Gas Temp. (°K)	Emission Point Type
Tennessee Copper-Copperhill	34-59-46 84-22-43	20	61	3.0	325	7.6	339	AP#4,5 Stack
		20	76.2	3.0	520	7.6	339	AP#6 Stack
		80	30.5	1.5	1,750	20.3	298	Captured Furnace Fugitives
		645	30.5	---	2,400	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	--	298	Misc. Fugitives

*This is the vertical cross sectional area of the emission point to the mean wind direction for the purpose of calculating downwash.

TABLE C.14. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
ASARCO-El Paso (a)	31-46-54 106-31-23	15,825	252	4.9	3,606	20.4	366	Main Stack
		275	31	1.7	84	14.8	339	Converter/AP Stack
		310	40	2.7	110	7.4	337	Roaster/AP Stack
		7,095	30.5	---	3,720	0.8	320	Converter Building Fugitives
		710	0	---	---	---	298	Furnace Building Fugitives
		1,805	0	---	---	---	298	Misc. Fugitives
ASARCO-El Paso (b)	31-46-54 106-31-23	13,070	252	4.9	3,606	20.4	366	Main Stack
		275	31	1.7	84	14.8	339	Converter/AP Stack
		310	40	2.7	110	7.4	337	Roaster/AP Stack
		2,105	30.5	---	3,720	0.8	320	Converter Building Fugitives
		710	0	---	---	---	298	Furnace Building Fugitives
		1,805	0	---	---	---	298	Misc. Fugitives
ASARCO-Hayden	33-00-30 110-46-33	2,390	305	5.2	6,300	12.8	339	Main Stack
		19,265	30.5	---	4,200	0.8	320	Converter Building Fugitives
		845	0	---	---	---	298	Furnace Building Fugitives
		3,270	0	---	---	---	298	Misc. Fugitives
Kennecott-Hayden	33-00-41 110-46-46	27,350	183	5.2	1,685	5.2	533	Furnace Stack
		40	30.5	2.4	84	10.4	352	Roaster/Converter/AP Stack
		250	61	2.6	325	20.3	320	Converter Fugitives Stack
		480	30.5	---	4,650	0.8	320	Converter Building Fugitives
		835	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		95	0	---	---	---	298	Furnace Building Fugitives
		35	0	---	---	---	298	Misc. Fugitives
Kennecott-Hurley	32-41-56 108-07-19	140	190.5	10.0	1,750	3.8	339	Main Stack
		15	61	3.0	325	20.3	320	Converter Fugitives Stack
		170	30.5	---	6,300	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.14. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS) (Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Kennecott-McGill	39-24-33	102,340	229	4.7	2,725	20.4	422	Main Stack
	114-46-12	380	61	3.0	325	20.3	320	Converter Fugitives Stack
		1,300	30.5	---	3,140	0.8	320	Converter Building Fugitives
		315	30.5	1.5	1,300	20.3	298	Captured Furnace Fugitives
		35	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Kennecott-Garfield	40-43-15	15,395	366	7.3	9,140	11.3	339	Main Stack
	112-11-53	12,650	30.5	---	4,800	0.8	320	Converter Building Fugitives
		205	0	---	---	---	298	Furnace Building Fugitives
		2,410	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Morenci	33-03-32	1,230	184	9.1	2,200	0.8	352	Reverb/AP Stack
	109-20-18	190	184	9.1	2,200	4.8	352	Converter/AP Stack
		70	184	9.1	2,200	4.8	352	Converter Fugitive Stack
		240	30.5	---	11,200	0.8	320	Converter Building Fugitives
		25	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Douglas	31-20-38	19,090	166	6.7	1,685	10.3	480	Main Stack
	109-35-11	19,470	172	5.5	1,770	7.6	464	Converter Stack
		465	61	4.7	325	20.3	320	Converter Fugitives Stack
		465	30.5	---	3,490	0.8	320	Converter Building Fugitives
		65	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.14. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS
(ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS)
(Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Phelps Dodge-Ajo	32-22-00 112-51-18	13,270	110	4.6	846	5.0	352	Main Stack
		15	61	2.6	325	20.3	320	Converter Fugitives Stack
		205	30.5	---	3,720	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Hidalgo	31-45-11 108-31-18	325	61	2.3	325	4.1	352	AP Stack
		40	183	5.5	2,000	6.6	401	Slag Furnace Stack
		10	61	2.6	325	20.3	320	Converter Fugitives Stack
		110	30.5	---	3,600	0.8	320	Converter Building Stack
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Copper Range-White Pine	46-46-06 089-33-18	2,375	154	4.6	1,295	4.6	494	Main Stack
		10	61	2.0	325	20.3	320	Converter Fugitives Stack
		15	30.5	---	3,255	0.8	320	Converter Building Fugitives
		50	30.5	1.5	3,800	20.3	298	Captured Furnace Fugitives
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Magma-San Manuel	32-36-57 110-37-22	10,920	155	6.4	2,100	5.9	519	Furnace Stack
		15	76	3.0	400	6.2	325	Converter/AP#1 Stack
		15	76	3.0	400	6.2	325	Converter/AP#2 Stack
		15	61	3.6	325	20.3	320	Converter Fugitives Stack
		90	30.5	---	4,200	0.8	320	Converter Building Fugitives
		75	30.5	1.5	5,250	20.3	298	Captured Furnace Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives

TABLE C.14. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS) (Concluded)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Inspiration-Miami	33-24-43 110-51-00	390	61	3.1	325	7.1	327	Furnace/Converter/ AP Stack
		70	61	3.0	325	20.3	320	Converter Fugitives Stack
		810	30.5	---	6,000	0.8	320	Converter Building Fugitives
		730	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		70	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives
Tennessee Copper-Copperhill	34-59-46 84-22-43	20	61	3.0	325	7.6	339	AP#4,5 Stack
		20	76.2	3.0	520	7.6	339	AP#6 Stack
		25	61	2.0	325	20.3	320	Converter Fugitives Stack
		80	30.5	1.5	1,750	20.3	298	Captured Furnace Fugitives
		40	30.5	---	2,400	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives

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* This is the vertical cross section area of the emission point to the mean wind direction for the purpose of calculating downwash.

TABLE C.15. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS
(ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS AND MATTE AND SLAG TAPPPING OPERATIONS)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
ASARCO- El Paso (a)	31-46-54 106-31-23	15,825	252	4.9	3,606	20.4	366	Main Stack
		275	31	1.7	84	14.8	339	Converter/AP Stack
		310	40	2.7	110	7.4	337	Roaster/AP Stack
		7,095	30.5	---	3,720	0.8	320	Converter Building Fugitives
		710	0	---	---	---	298	Furnace Building Fugitives
		1,805	0	---	---	---	298	Misc. Fugitives
ASARCO- El Paso (b)	31-46-54 106-31-23	13,070	252	4.9	3,606	20.4	366	Main Stack
		275	31	1.7	84	14.8	339	Converter/AP Stack
		310	40	2.7	110	7.4	337	Roaster/AP Stack
		2,105	30.5	---	3,720	0.8	320	Converter Building Fugitives
		710	0	---	---	---	298	Furnace Building Fugitives
		1,805	0	---	---	---	298	Misc. Fugitives
ASARCO- Hayden	33-00-30 110-46-33	2,390	305	5.2	6,300	12.8	339	Main Stack
		19,265	30.5	---	4,200	0.8	320	Converter Building Fugitives
		845	0	---	---	---	298	Furnace Building Fugitives
		3,270	0	---	---	---	298	Misc. Fugitives
Kennecott- Hayden	33-00-41 110-46-46	27,350	183	5.2	1,685	5.2	533	Furnace Stack
		40	30.5	2.4	84	10.4	352	Roaster/Converter/AP Stack
		250	61	2.6	325	20.3	320	Converter Fugitives Stack
		480	30.5	---	4,650	0.8	320	Converter Building Fugitives
		35	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		95	0	---	---	---	298	Furnace Building Fugitives
		35	0	---	---	---	298	Misc. Fugitives
Kennecott- Hurley	32-41-56 108-07-19	45	190.5	10.0	1,750	3.8	339	Main Stack
		15	61	3.0	325	20.3	320	Converter Fugitives Stack
		170	30.5	---	6,300	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.15. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS (ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS AND MATTE AND SLAG TAPPPING OPERATIONS) (Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Kennecott-McGill	39-24-33 114-46-12	102,340	229	4.7	2,725	20.4	422	Main Stack
		380	61	3.0	325	20.3	320	Converter Fugitives Stack
		1,300	30.5	---	3,140	0.8	320	Converter Building Fugitives
		10	30.5	1.5	1,300	20.3	298	Captured Furnace Fugitives
		35	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Kennecott-Garfield	40-43-15 112-11-53	13,665	366	7.3	9,140	11.3	339	Main Stack
		12,650	30.5	---	4,800	0.8	320	Converter Building Fugitives
		205	0	---	---	---	298	Furnace Building Fugitives
		2,410	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Morenci	33-03-32 109-20-18	1,015	184	9.1	2,200	0.8	352	Reverb/AP Stack
		190	184	9.1	2,200	4.8	352	Converter/AP Stack
		70	184	9.1	2,200	4.8	352	Converter Fugitives Stack
		240	30.5	---	11,200	0.8	320	Converter Building Fugitives
		25	0	---	---	---	298	Furnace Building Fugitives
		25	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Douglas	31-20-38 109-35-11	19,090	166	6.7	1,685	10.3	480	Main Stack
		19,115	172	5.5	1,770	7.6	464	Converter Stack
		465	61	4.7	325	20.3	320	Converter Fugitives Stack
		465	30.5	---	3,490	0.8	320	Converter Building Fugitives
		65	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives
Phelps Dodge-Ajo	32-22-00 112-51-18	13,180	110	4.6	846	5.0	352	Main Stack
		15	61	2.6	325	20.3	320	Converter Fugitives Stack
		205	30.5	---	3,720	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives

TABLE C.15. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS
(ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS AND MATTE AND SLAG TAPPPING OPERATIONS)
(Continued)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Phelps Dodge-Hidalgo	31-45-11 108-31-18	325	61	2.3	325	4.1	352	AP Stack
		40	183	5.5	2,000	6.6	401	Slag Furnace Stack
		10	61	2.6	325	20.3	320	Converter Fugitives Stack
		110	30.5	---	3,600	0.8	320	Converter Building Stack
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Copper Range-White Pine	46-46-06 089-33-18	2,375	154	4.6	1,295	4.6	494	Main Stack
		10	61	2.0	325	20.3	320	Converter Fugitives Stack
		15	30.5	---	3,255	0.8	320	Converter Building Fugitives
		5	30.5	1.5	3,800	20.3	298	Captured Furnace Fugitives
		5	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Magma-San Manuel	32-36-57 110-37-22	10,920	155	6.4	2,100	5.9	519	Furnace Stack
		15	76	3.0	400	6.2	325	Converter/AP#1 Stack
		15	76	3.0	400	6.2	325	Converter/AP#2 Stack
		15	61	3.6	325	20.3	320	Converter Fugitives Stack
		90	30.5	---	4,200	0.8	320	Converter Building Fugitives
		5	30.5	1.5	5,250	20.3	298	Captured Furnace Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives
Inspiration-Miami	33-24-43 110-51-00	390	61	3.1	325	7.1	327	Furnace/Converter/ AP Stack
		70	61	3.0	325	20.3	320	Converter Fugitives Stack
		810	30.5	---	6,000	0.8	320	Converter Building Fugitives
		30	30.5	1.1	1,750	20.3	298	Captured Furnace Fugitives
		70	0	---	---	---	298	Furnace Building Fugitives
		15	0	---	---	---	298	Misc. Fugitives

TABLE C.15. INPUT DATA TO EXPOSURE MODEL LOW-ARSENIC PRIMARY COPPER SMELTERS
(ASSUMING BAT CONTROLS AT CONVERTER OPERATIONS AND MATTE AND SLAG TAPPING OPERATIONS)
(Concluded)

Plant	Latitude/ Longitude (Degrees Minutes Seconds)	Arsenic Emission Rate (kg/yr)	Emission Point Elevation (Meters)	Emission Point Diameter (Meters)	Emission* Point Cross Sectional Area (m^2)	Emission Point Gas Exit Velocity (m/sec)	Emission Point Gas Temp. (°K)	Emission Point Type
Tennessee Copper-Copperhill	34-59-46 84-22-43	20	61	3.0	325	7.6	339	AP#4,5 Stack
		20	76.2	3.0	520	7.6	339	AP#6 Stack
		25	61	2.0	325	20.3	320	Converter Fugitives Stack
		5	30.5	1.5	1,750	20.3	298	Captured Furnace Fugitives
		40	30.5	---	2,400	0.8	320	Converter Building Fugitives
		10	0	---	---	---	298	Furnace Building Fugitives
		5	0	---	---	---	298	Misc. Fugitives

* This is the vertical cross sectional area of the emission point to the mean wind direction for the purpose of calculating downwash.

TABLE C.16 TOTAL EXPOSURE AND NUMBER OF PEOPLE EXPOSED (LOW-ARSENIC PRIMARY COPPER SMELTERS)*

Plant	Total Number of People Exposed	Total Exposure (People - $\mu g/m^3$)
1	493,000	6230**
2	46,800	952
3	46,800	256
4	26,300	13
5	7,350	95
6	810,000	2350
7	25,500	46
8	31,100	355***
9	6,600	73
10	2,560	1
11	16,900	7
12	211,000	42
13	35,700	113
14	164,000	54

* A 50-kilometer radius was used for the analysis of low-arsenic primary copper smelters.

** Value for total exposure calculated on the basis of site-specific analysis for ASARCO-El Paso, TX was 2980.

*** Value for total exposure calculated on the basis of site-specific analysis for Phelps-Dodge-Douglas, AZ was 409.

TABLE C.17

PUBLIC EXPOSURE FOR LOW-ARSENIC COPPER SMELTERS AS PRODUCED BY THE HUMAN EXPOSURE MODEL

Concentration Level (μg/m^3)	Population Exposed (Persons)*	Exposure (Persons - μg/m^3)**
2.75	1	3
2.5	1	3
1.0	22	31
0.5	124	99
0.25	664	283
0.1	3980	744
0.05	11700	1270
0.025	72500	3270
0.01	265000	6160
0.005	484000	7670
0.0025	1100000	9790
0.001	1480000	10500
0.0005	1520000	10500
0.00025	1570000	10600
0.0001	1660000	10600
0.00005	1880000	10600
0.000025	1920000	10600

*Column 2 displays the computed value, rounded to the nearest whole number, of the cumulative number of people exposed to the matching and higher concentration levels found in column 1. For example, 0.5 people would be rounded to 0 and 0.51 people would be rounded to 1.

**Column 3 displays the computed value of the cumulative exposure to the matching and higher concentation levels found in column 1.

C.4 QUANTITATIVE EXPRESSIONS OF PUBLIC CANCER RISKS FROM INORGANIC ARSENIC EMITTED FROM LOW-ARSENIC PRIMARY COPPER SMELTERS

C.4.1 Methodology (General)

C.4.1.1 The Two Basic Types of Risk

Two basic types of risk are dealt with in the analysis. "Aggregate risk" applies to all of the people encompassed by the particular analysis. Aggregate risk can be related to a single source, to all of the sources in a source category, or to all of the source categories analyzed. Aggregate risk is expressed as incidences of cancer among all of the people included in the analysis, after 70 years of exposure. For statistical convenience, it is often divided by 70 and expressed as cancer incidences per year. "Individual risk" applies to the person or persons estimated to live in the area of the highest ambient air concentrations and it applies to the single source associated with this estimate as estimated by the dispersion model. Individual risk is expressed as "maximum lifetime risk" and reflects the probability of getting cancer if one were continuously exposed to the estimated maximum ambient air concentration for 70 years.

C.4.1.2 The Calculation of Aggregate Risk

Aggregate risk is calculated by multiplying the total exposure produced by HEM (for a single source, a category of sources, or all categories of sources) by the unit risk estimate. The product is cancer incidences among the included population after 70 years of exposure. The total exposure, as calculated by HEM, is illustrated by the following equation:

$$\text{Total Exposure} = \sum_{i=1}^{N} (P_i C_i)$$

where

Σ = summation over all grid points where exposure is calculated

P_i = population associated with grid point i,

C_i = long-term average inorganic arsenic concentration at grid point i,

N = number of grid points to 2.8 kilometers and number of ED/BG centroids between 2.8 and 50 kilometers of each source.

To more clearly represent the concept of calculating aggregate risk, a simplified example illustrating the concept follows:

EXAMPLE

This example uses assumptions rather than actual data and uses only three levels of exposure rather than the large number produced by HEM. The assumed unit risk estimate is 4.29×10^{-3} at 1 $\mu g/m^3$ and the assumed exposures are:

ambient air concentrations	number of people exposed to given concentration
2 $\mu g/m^3$	1,000
1 $\mu g/m^3$	10,000
0.5 $\mu g/m^3$	100,000

The probability of getting cancer if continuously exposed to the assumed concentrations for 70 years is given by:

concentration		unit risk		probability of cancer
2 $\mu g/m^3$	x	4.29×10^{-3} $(\mu g/m^3)^{-1}$	=	9×10^{-3}
1 $\mu g/m^3$	x	4.29×10^{-3} "	=	4×10^{-3}
0.5 $\mu g/m^3$	x	4.29×10^{-3} "	=	2×10^{-3}

The 70 year cancer incidence among the people exposed to these concentrations is given by:

probability of cancer at each exposure level		number of people at each exposure level		after 70 years of exposure
9×10^{-3}	x	1,000	=	9
4×10^{-3}	x	10,000	=	40
2×10^{-3}	x	100,000	=	200
				TOTAL = 249

The aggregate risk, or total cancer incidence, is 249 and, expressed as cancer incidence per year, is 249 ÷ 70, or 3.6 cancers per year. The total cancer incidence and cancers per year apply to the total of 111,000 people assumed to be exposed to the given concentrations.

C.4.1.3 The Calculation of Individual Risk

Individual risk, expressed as "maximum lifetime risk," is calculated by multiplying the highest concentration to which the public is exposed, as reported by HEM, by the unit risk estimate. The product, a probability of getting cancer, applies to the number of people which HEM reports as being exposed to the highest listed concentration. The concept involved is a simple proportioning from the 1 $\mu g/m^3$ on which the unit risk estimate is based to the highest listed concentration. In other words:

$$\frac{\text{maximum lifetime risk}}{\text{highest concentration to which people are exposed}} = \frac{\text{the unit risk estimate}}{1\ \mu g/m^3}$$

C.4.2 Risks Calculated for Emissions of Inorganic Arsenic from Primary Copper Smelters

The explained methodologies for calculating maximum lifetime risk and cancer incidences were applied to each copper smelter, assuming a baseline level of emissions. A baseline level of emissions means the level of emissions after the application of controls either currently in place or required to be in place to comply with curent state or Federal regulations but before application of controls that would be required by a NESHAP.

Tables C.18 and C.19 summarize the calculated risks. To understand the relevance of these numbers, one should refer to the analytical uncertainties discussed in section C.5 below.

C.4.2.1 Control Scenarios

EPA completed HEM estimates of risk and incidence for the baseline, or no-control, case at each of 14 copper smelters (see discussion, Section C.3.1.3). Their estimates are outlined in Tables C.11 and C.12. In order to ascertain the effect on maximum individual lifetime risk and on annual incidence, two pollution control scenerios were also examined. Using modified emissions estimates as inputs to the HEM model (Tables C.7 and C.8), EPA calculated risk and incidence values (Tables C.11 and C.12) for a control option for converter operations only and a control option covering converter and matte and slag tapping operations. Identical procedures were followed in risk and incidence calculations for the baseline and control scenerios.

For each of the fourteen smelter locations, a detailed check was made to determine whether the location of the most exposed individual was realistically placed by computer. A review of U.S. Geological Survey maps revealed some discrepancies at ten of the smelter sites. In these cases, the model placed the populations near sites which had high ambient arsenic concentrations but which clearly did not contain settlements. Such sites included tailings ponds, railroad tracks and locations in rugged terrain. For the purpose of risk and incidence estimation the distance and bearing of actual exposed populations were revised. In all cases where the point of maximum exposure was changed, that point remained the same for the control cases as well.

C.5 ANALYTICAL UNCERTAINTIES APPLICABLE TO THE CALCULATIONS OF PUBLIC HEALTH RISKS CONTAINED IN THIS APPENDIX

C.5.1 The Unit Risk Estimate

The procedure used to develop the unit risk estimate is described in reference 2. The model used and its application to epidemiological data have been the subjects of substantial comment by health scientists. The uncertainties are too complex to be summarized sensibly in this appendix. Readers who wish to go beyond the information presented in the reference should see the following Federal Register notices: (1) OSHA's "Supplemental Statement of Reasons for the Final Rule", 48 FR 1864 (January 14, 1983);

TABLE C.18 MAXIMUM LIFETIME RISK FOR LOW-ARSENIC PRIMARY COPPER SMELTER PLANTS

		Maximum Individual Lifetime Risk		
Source		Baseline	Converter Controls	Converter & Matte & Slag Tapping Control
ASARCO-El Paso**	(a)	1×10^{-3}	8×10^{-4}	8×10^{-4}
	(b)	6×10^{-4}	5×10^{-4}	5×10^{-4}
		1×10^{-3}*	9×10^{-4}*	---
ASARCO-Hayden		1.3×10^{-3}	1.2×10^{-3}	1.2×10^{-3}
Kennecott-Hayden		3×10^{-4}	5×10^{-5}	4×10^{-5}
Kennecott-Hurley		1.2×10^{-4}	5×10^{-5}	5×10^{-5}
Kennecott-McGill		4×10^{-4}	6×10^{-5}	6×10^{-5}
Kennecott-Garfield		6×10^{-5}	6×10^{-5}	6×10^{-5}
Phelps Dodge-Morenci		8×10^{-5}	2×10^{-5}	2×10^{-5}
Phelps Dodge-Douglas***		1.2×10^{-3}	2×10^{-4}	2×10^{-4}
		8×10^{-5}*	7×10^{-5}*	---
Phelps Dodge-Ajo		2×10^{-4}	1.7×10^{-4}	2×10^{-4}
Phelps Dodge-Hidalgo		5×10^{-6}	3×10^{-6}	3×10^{-6}
Copper Range-White Pine		1.1×10^{-4}	1.5×10^{-5}	1.5×10^{-5}
Magma-San Manuel		1.6×10^{-4}	4×10^{-5}	4×10^{-5}
Inspiration-Miami		1.9×10^{-4}	1.0×10^{-4}	9×10^{-5}
Tennessee Copper-Copperhill		6×10^{-5}	1.0×10^{-5}	8.6×10^{-6}

* Represents risk estimates calculated from site-specific analyses using ISCLT/Valley model.

** Although EPA recognizes the potential Mexican population exposure, available data are insufficient to make HEM exposure/risk calculation. Crude estimates indicate that the individual risk estimate for the Mexican population is approximately the same magnitude as reported in the above table.

*** Although EPA recognizes the potential Mexican population exposure, available data are insufficient to make HEM exposure/risk calculation. Crude estimates indicate that the individual risk estimate for the Mexican population is smaller than reported in the above table.

TABLE C.19
ANNUAL INCIDENCE ESTIMATES FOR ARSENIC PRIMARY COPPER SMELTERS

	Annual Incidence		
Source	Baseline	Converter Controls	Converter & Matte & Slag Tapping Controls
ASARCO-El Paso** (a)	0.38	0.29	0.29
(b)	0.20	0.18	0.18
	0.18*	0.16*	---
ASARCO-Hayden	0.058	0.050	0.050
Kennecott-Hayden	0.016	0.0054	0.0043
Kennecott-Hurley	0.0008	0.0003	0.0003
Kennecott-McGill	0.0058	0.0015	0.0014
Kennecott-Garfield	0.14	0.14	0.14
Phelps Dodge-Morenci	0.0028	0.0009	0.0008
Phelps Dodge-Douglas**	0.022	0.0081	0.0080
	0.025*	0.013*	---
Phelps Dodge-Ajo	0.0045	0.0038	0.0038
Phelps Dodge-Hidalgo	0.0001	0.0001	0.0001
Copper Range-White Pine	0.0004	0.0002	0.0001
Magma-San Manuel	0.0026	0.0017	0.0016
Inspiration-Miami	0.0069	0.0034	0.0023
Tennessee Copper-Copperhill	0.0033	0.0006	0.0004

* Represents incidence estimates calculated from site-specific analyses using ISCLT/Valley model.

** Although EPA recognizes the potential Mexican population exposure, available data are insufficient to make HEM exposure/risk calculation. Crude estimates indicate that the Mexican annual incidence is approximately of the same magnitude as reported in the above table.

and (2) EPA's "Water Quality Documents Availability" 45 FR 79318 (November 28, 1980).

The unit risk estimate used in this analysis applies only to lung cancer. Other health effects are possible; these include skin cancer, hyperkeratosis, peripheral neuropathy, growth retardation and brain dysfunction among children, and increase in adverse birth outcomes. No numerical expressions of risks relevant to these health effects is included in this analysis.

Although the estimates derived from the various studies are quite consistent, there are a number of uncertainties associated with them. The estimates were made from occupational studies that involved exposures only after employment age was reached. In estimating risks from environmental exposures throughout life, it was assumed through the absolute-risk model that the increase in the age-specific mortality rates of lung cancer was a function only of cumulative exposures, irrespective of how the exposure was accumulated. Although this assumption provides an adequate description of all of the data, it may be in error when applied to exposures that begin very early in life. Similarly, the linear models possibly are inaccurate at low exposures, even though they provide reasonable descriptions of the experimental data.

The risk assessment methods employed were severely constrained by the fact that they are based only upon the analyses performed and reported by the original authors--analyses that had been performed for purposes other than quantitative risk assessment. For example, although other measures of exposure might be more appropriate, the analyses were necessarily based upon cumulative dose, since that was the only usable measure reported. Given greater access to the data from these studies, other dose measures, as well as models other than the simple absolute-risk model, could be studied. It is possible that such wide analyses would indicate that other approaches are more appropriate than the ones applied here.

C.5.2 Public Exposure

C.5.2.1 General

The basic assumptions implicit in the methodology are that all exposure occurs at people's residences, that people stay at the same location for 70 years, that the ambient air concentrations and the emissions which cause these concentrations persist for 70 years, and that the concentrations are the same inside and outside the residences. From this it can be seen that public exposure is based on a hypothetical premise. It is not known whether this results in an over-estimation or an underestimation of public exposure.

C.5.2.2 The Public

The following are relevant to the public as dealt with in this analysis:

1. Studies show that all people are not equally susceptible to cancer. There is no numerical recognition of the "most susceptible" subset of the population exposed.

2. Studies indicate that whether or not exposure to a particular carcinogen results in cancer may be affected by the person's exposure to other substances. The public's exposure to other substances is not numerically considered.

3. Some members of the public included in this analysis are likely to be exposed to inorganic arsenic in the air in the workplace, and workplace air concentrations of a pollutant are customarily much higher than the concentrations found in the ambient, or public air. Workplace exposures are not numerically approximated.

4. Studies show that there is normally a long latent period between exposure and the onset of lung cancer. This has not been numerically recognized.

5. The people dealt with in the analysis are not located by actual residences. As explained previously, people are grouped by census districts and these groups are located at single points called the population centroids. The effect is that the actual locations of residences with respect to the estimated ambient air concentrations are not known and that the relative locations used in the exposure model may have changed since the 1980 census. However, for the population sectors estimated to be at highest risk, U.S. Geological Survey topographical maps were checked to verify that people did live or could live in locations near the sources as modeled predictions estimated. Maps in certain instances were old and the possibility could not be excluded that additional areas near sources have been developed since publication of the maps.

6. Many people dealt with in this analysis are subject to exposure to ambient air concentrations of inorganic arsenic where they travel and shop (as in downtown areas and suburban shopping centers), where they congregate (as in public parks, sports stadiums, and schoolyards), and where they work outside (as mailmen, milkmen, and construction workers). These types of exposures are not numerically dealt with.

C.5.2.3. The Ambient Air Concentrations

The following are relevant to the estimated ambient air concentrations of inorganic arsenic used in this analysis:

1. Flat terrain was assumed in the dispersion model. Concentrations much higher than those estimated would result if emissions impact on elevated terrain or tall buildings near a plant.

2. The estimated concentrations do not account for the additive impact of emissions from plants located close to one another.

3. The increase in concentrations that could result from re-entrainment of arsenic-bearing dust from, e.g., city streets, dirt roads, and vacant lots, is not considered.

4. Meteorological data specific to plant sites are not used in the dispersion model. As explained, HEM uses the meteorological data from the STAR station nearest the plant site. Site-specific meteorological data could result in significantly different estimates, e.g., the estimated location of the highest concentrations.

5. In some cases, the arsenic emission rates are estimates that are based on assumptions rather than on measured data.

C.6 REFERENCES

1. National Academy of Sciences, "Arsenic," Committee on Medical and Biological Effects of Environmental Pollutants, Washington, D.C., 1977. Docket Number (OAQPS 79-8) II-A-3.

2. Health Assessment Document for Inorganic Arsenic - Final Report EPA-600/ 8-83-021F March 1984, OAQPS Docket Number OAQPS 79-8, II-A-13.

3. U.S. EPA, et.al., "Environmental Cancer and Heart and Lung Disease," Fifth Annual Report to Congress by the Task Force on Environmental Cancer and Health and Lung Disease, August, 1982.

4. OAQPS Guideline Series, "Guidelines on Air Quality Models". Publication Number EPA-450/2-78-027, (OAQPS Guideline No. 1.2-080).

5. Systems Application, Inc., "Human Exposure to Atmospheric Concentrations of Selected Chemicals." (Prepared for the U.S. Environmental Protection Agency, Research Triangle Park, North Carolina). Volume I, Publication Number EPA-2/250-1, and Volume II, Publication Number EPA-1/250-2.

APPENDIX D

SUMMARY OF TEST RESULTS FOR AIR CURTAIN SECONDARY HOOD SYSTEM AT ASARCO-TACOMA

SUMMARY OF TEST RESULTS
FOR AIR CURTAIN SECONDARY HOOD SYSTEM
AT ASARCO-TACOMA

From January 14 to 22, 1983, EPA performed a series of tests to evaluate the effectiveness of the air curtain secondary hood system installed on the No. 4 converter at the ASARCO-Tacoma smelter. The test program was designed to achieve two major objectives: (1) estimation of capture efficiency of the air curtain secondary hood system; and (2) characterization of the captured emissions. Sample and analytical procedures were performed by personnel from an EPA contractor (PEDCo Environmental, Inc.), under the supervision of personnel from the EPA Industrial Environmental Research Laboratory and the Emission Standards and Engineering Division. The complete, two-volume test report is available in the docket (docket references IV-A-4 and IV-A-5).

D.1 AIR CURTAIN SECONDARY HOOD CAPTURE EFFECTIVENESS

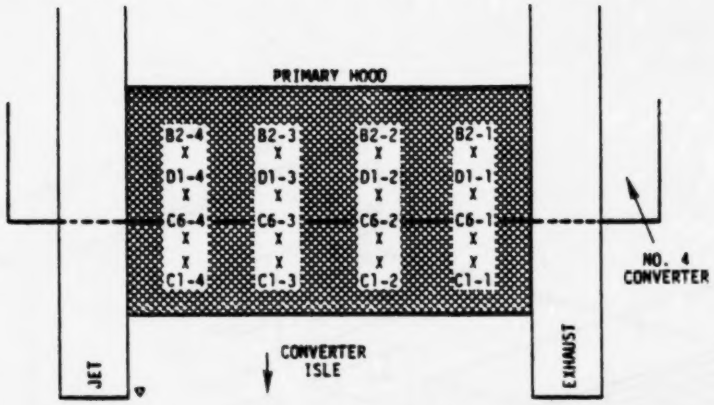
Three methods were tried to evaluate the air curtain secondary hood capture effectiveness: (1) mass balance using sulfur hexafluoride (SF_6) as a tracer; (2) opacity of emissions escaping through the air curtain; and (3) visual emissions observations.

D.1.1 Gas Tracer Method

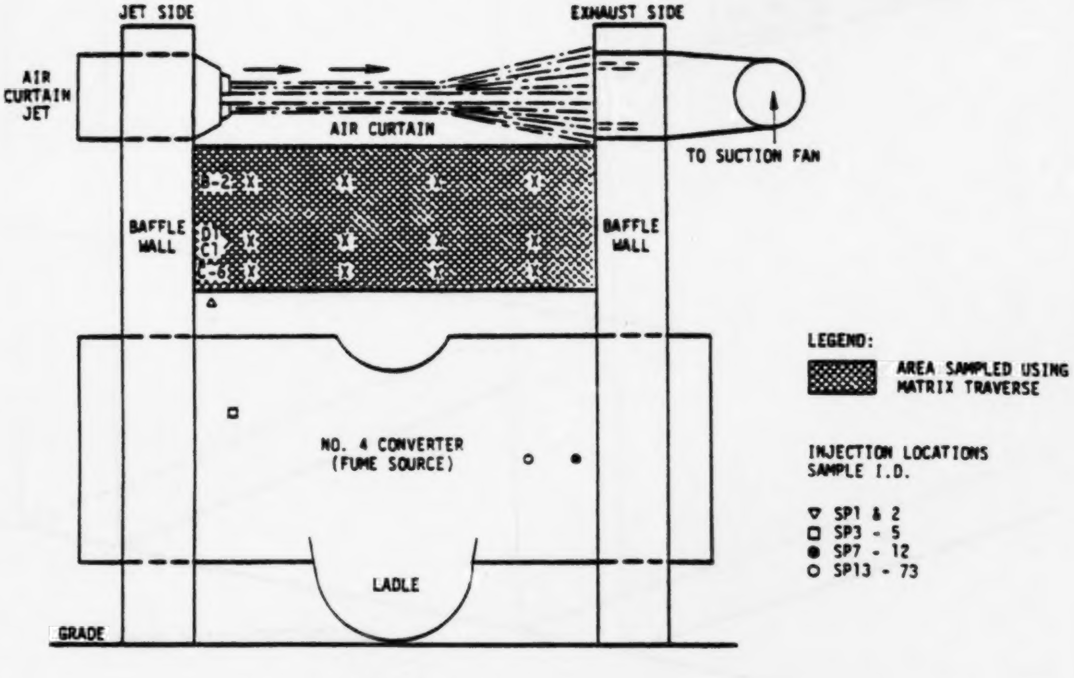
For the gas tracer method, SF_6 was injected into the controlled area of the air curtain at constant, known rates of 30 to 50 cc/min for periods that ranged from 15 minutes to 2 hours per injection. Single point samples of the exhaust gases from the air curtain hood were collected at a downstream sampling location by pulling samples into 15-liter, leak-free Tedlar bags for onsite gas chromatographic analysis. The air curtain capture efficiency was calculated by comparing the SF_6 injection mass flow rate with the mass flow rate calculated for the downstream sampling point.

Injections of SF_6 gas were made at 16 sample points through 4 test ports in adjacent access doors on both sides of the converter baffle walls. The locations of the points are shown in Figures D-1 and D-2. In addition to the efficiency measurements made for the points in the primary testing area, several tests were performed at injection points outside of this area (below the converter centerline) in an attempt to characterize the effective capture area of the air curtain hooding system, particularly during converter roll-out activities.

On January 14, 1983, capture efficiencies were determined for 45 injection points in the controlled area. The calculated mean efficiencies by converter operational mode are presented in Table D-1. The overall mean capture efficiency for all modes of operation was 93.5 percent. With the exception of cold additions, the operating mode of the converter had little effect on the measured capture efficiency, which ranged from 92.8 percent during blowing to 95.0 percent during



TOP VIEW



ELEVATION

Figure D-1. SF_6 Tracer Injection Matrix

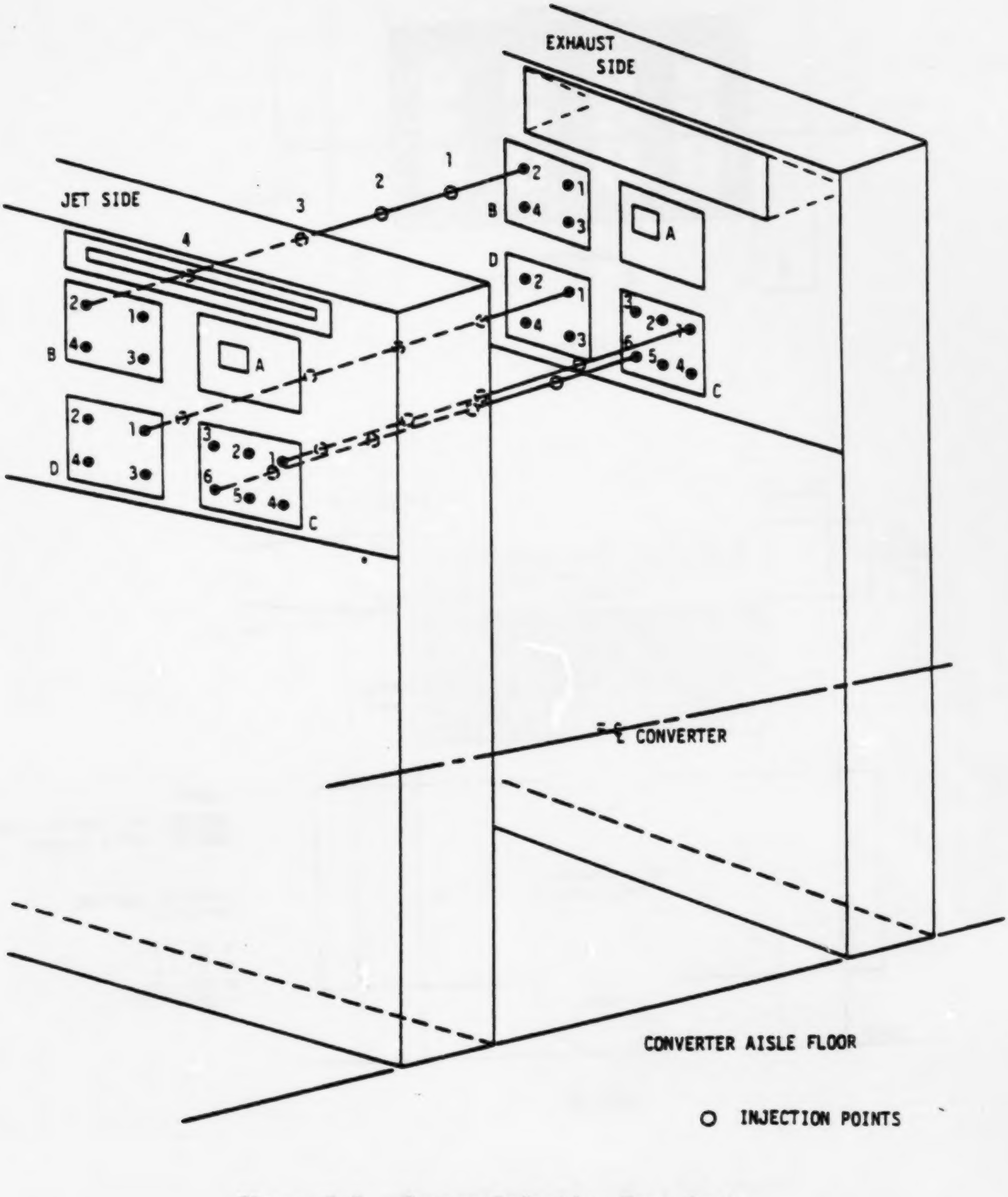


Figure D-2. Tracer Injection Test Ports

Table D-1. AIR CURTAIN CAPTURE EFFICIENCIES AT ASARCO-TACOMA USING GAS TRACER METHOD - JANUARY 14, 1983

Converter mode	Number of injections	Mean Efficiency
Matte charge	7	93.1
Cold addition	3	102.0
Blowing	19	92.8
Slag skimming	9	95.0
Idle	7	93.4
TOTAL	45	93.5[a]

[a] Calculated overall mean efficiency assumes the converter operation consists of 80 percent blowing and idle, 15 percent matte charge and cold addition, and 5 percent slag skimming.

slag skimming. The port through which the releases of tracer gas were made did not have any effect on the calculated efficiency. However, it was found that sampling points tested through a particular port exhibited considerable variation, generally recording higher capture efficiencies at positions 1 and 2 (exhaust side) than at position 3 and 4 (jet side).

The remaining test series of 48 injections was performed on January 17-18, 1983. The results of this series are summarized in Table D-2.

Table D-2. AIR CURTAIN CAPTURE EFFICIENCIES AT ASARCO-TACOMA USING GAS TRACER METHOD - JANUARY 17-19, 1983

Converter mode	Number of injections	Mean Efficiency
Matte charge	6	94.2
Cold addition	3	96.7
Blowing	27	96.7
Slag skimming	7	94.3
Copper pour	4	88.5
Idle	4	100.0
TOTAL	51	96.5[a]

[a] Calculated overall mean efficiency assumes the converter operation consists of 80 percent blowing and idle, 15 percent matte charge and cold addition, and 5 percent slag skimming and copper pour.

The overall mean capture efficiency for all operational modes was 96.5 percent. As with the data recorded on January 14, the operating mode appeared to have no significant effect on the individual calculated efficiencies, which ranged from 88.5 percent during copper pouring to 96.7 percent during both blowing and cold additions. However, any consistent, small variations in the efficiencies for various modes, if they were present, would be difficult to detect in the relatively small number of test runs (injections) that were made. The error in the calculated air curtain capture efficiencies has been estimated to be ±18 percent. For this second test series, it was also found that the location of the test port had no effect on efficiency, while exhaust-side efficiencies were found to be somewhat higher than jet-side efficiencies. Test results from the injection points in these tests indicate that on the average, about 95 percent of the gases and particulate matter in the area immediately above the converter is likely to be captured by the air curtain secondary hooding system.

In addition to these two test series, a series of special injection point tests was conducted in order to assess the effective capture area of the secondary hood system outside the confines of the hood. The special injection tests were performed with the injection probe at a number of points on the perimeter of the main test area, such as very close to the baffle wall and below the ladle during the matte charging and cold addition modes. Table D-3 shows the results of this test series.

Table D-3. AIR CURTAIN CAPTURE EFFICIENCIES AT ASARCO-TACOMA FOR SPECIAL GAS TRACER INJECTION POINTS - JANUARY 18-20, 1983

Converter mode	Number of injections	Mean Efficiency
Matte charge	17	61.8
Cold addition	6	61.5
Blowing	6	33.0
Slag skimming	28	84.0
Copper pour	4	80.8
Idle	8	53.8
TOTAL	69	49.4[a]

[a] Calculated overall mean efficiency assumes the converter operation consists of 80 percent blowing and idle, 15 percent matte charge and cold addition, and 5 percent slag skimming and copper pour.

The overall average capture efficiency for the 69 special injection points was 49.4 percent. Unlike the first two test series, the capture efficiency in the special series was sensitive to converter mode. For example, the slag skimming and copper pour efficiencies are higher, at

84.0 and 80.8 percent, respectively, than the other modes because of the position of the ladle (above the injection probe) during these modes.

D.1.2 Opacity Measurement Method

An opacity monitor was mounted on the top of the air curtain below the crane rail in order to obtain information on emissions escaping capture by the air curtain and passing through the slot. A total of 86 discrete observations were made with results ranging from 2 to 54 percent opacity for the major converter operations. During slag and finish blowing, no attenuation of the monitor's light beam was observed, indicating zero percent opacity. The instrument output range was 0 to 20 milliamps, which corresponds to 0 to 98.4 percent opacity. The relationship of the instrument output to opacity is exponential, with 5 milliamps corresponding to 50 percent opacity. Therefore, emissions during the test program were in the lower end of instrument response. No correlation between opacity and capture effectiveness could be made because of emissions from the front of the air curtain system.

D.1.3 Visual Emissions Observation Method

Two observers visually monitored the air curtain capture effectiveness by noting the location, approximate opacity, and duration of visible emissions (see Section I-6.4). Their estimates of capture efficiency were within 5 to 10 percent of each other, with only a few exceptions. Most variability in the estimates occurred for those operations involving rapid evolution of emissions over a short period, such as roll-in, roll-out, and pouring. The average of the observations for the various converter operating conditions displayed the same trends as the tracer experiments and indicates a reasonably effective capture of fugitives.

D.1.4 Conclusions

In summary, the visual observation and tracer recovery data indicated that the fugitive emissions capture effectiveness of the air curtain secondary hood is greater than 90 percent, averaging about 94 percent overall. The capture effectiveness during converter roll-in, roll-out, and slag skimming operations is more variable than during other converter modes since fugitive emissions generated during these events are more dependent upon converter and crane operations. It was also evident from the observations that capture efficiencies of 90 percent or better are achievable for these events under the proper crane and converter operating conditions to minimize fume "spillage" into the converter aisle.

Thermal lift plays a significant role in increased collection efficiencies for fume generated in the lower portion of the control area. Also, the lower tracer recovery efficiencies for the various converter roll-out modes are indicative of fume spillage outside of the control area.

It is believed that no practical correlation can be made between opacities recorded by the observers and the transmissometer. The transmissometer was mounted perpendicular to the longitudinal axis of the slot, whereas the position of the observers was such that their view was parallel to the longitudinal axis of the slot, which resulted in a considerably longer viewing length through the escaping emissions. The apparent opacity increases as the path length through the emissions increases. Also, when positioned in front of the converter, the overhead crane interfered with visual observations above the slot area.

D.2 ARSENIC EMISSION DATA

Table D-4 summarizes the filterable and gaseous arsenic emissions data for tests conducted by EPA Reference Method 5 and proposed Method 108. Two sampling trains were used to obtain the particulate and arsenic samples. Sampling was performed for the duration of each converter cycle tested and during specific converter roll-out modes: matte charge, slag skim, cold additions, and copper pouring. Analysis for filterable and gaseous arsenic was performed at the completion of the gravimetric particulate determination.

Arsenic concentrations are reported in milligrams per dry standard cubic meter (mg/dscm) and grains per dry standard cubic foot (gr/dscf). Emission rates are expressed in kilograms per hour and pounds per hour. The product of the concentration and the volumetric flow rate is the mass emission rate. For the total cycle tests (designated PATC), the measured flow rate obtained from the sample traverse was used in the calculations. For tests conducted during converter roll-out activities (designated PASM), the average flow rate obtained from the volumetric flow evaluation of the high-flow mode was used because these tests were performed at a single point in the duct.

The filterable arsenic fraction represents material collected in the sample probe and on the filter, both of which were heated to approximately 121°C (250°F). The gaseous arsenic fraction represents material that passed through the heated filter and condensed or was trapped in the impinger section of the sample train, which was maintained at a temperature of 20°C (68°F) or less.

During the total cycle tests, the filterable arsenic concentration ranged from 1.35 mg/dscm (0.0006 gr/dscf) to 3.89 mg/dscm (0.0017 gr/dscf), and the corresponding mass emission rate ranged from 0.21 kg/h (0.47 lb/h) to 0.61 kg/h (1.36 lb/h). Gaseous arsenic concentrations during Tests PATC-1 and PATC-3 were 0.28 mg/dscm (0.0001 gr/dscf) and 0.44 mg/dscm (0.0002 gr/dscf), respectively.

During Test PATC-2, the gaseous arsenic concentration was 5.02 mg/dscm (0.002 gr/dscf). The loss of draft by the primary hood caused by operational problems at the chemical plant resulted in frequent releases of smoke and fumes from the primary hood. During this period, particularly in the converter blow mode, heavy volumes of smoke escaped the primary hood system, and some of these emissions were captured by the secondary hood. Sampling continued throughout these intermediate upsets, but was finally stopped when the air curtain control system became overwhelmed by continuous and heavy emission discharge from the primary hood. It appears reasonable to conclude that fugitive emissions

Table D-4. SUMMARY OF FILTERABLE AND GASEOUS ARSENIC EMISSION DATA

Cycle Test No.	Run No.	Date (1983)	Sampling period	Concentration[a]		Mass Emission Rate	
				Filterable mg/dscm (gr/dscf)	Gaseous mg/dscm (gr/dscf)	Filterable kg/h (lb/h)	Gaseous kg/h (lb/h)
1	PATC-1 PASM-1	1/18-19	1/18 909-1625 1/19 830-1322	2.18 (0.0009) 4.98 (0.002)	0.28 (0.0001) 0.86 (0.0004)	0.33 (0.73) 0.99 (2.18)	0.04 (0.08) 0.20 (0.44)
2	PATC-2 PASM-2	1/20	820-2003	3.89 (0.0017) 9.01 (0.004)	5.02 (0.002) 4.72 (0.002)	0.61 (1.35) 1.97 (4.35)	0.72 (1.59) 0.99 (2.18)
3	PATC-3 PASM-3[b]	1/22	910-2342	1.35 (0.0006) 5.86 (0.003)[b]	0.44 (0.0002) 0.24 (0.0001)[b]	0.21 (0.47) 1.48 (3.26)[b]	0.07 (0.16) 0.05 (0.11)[b]

[a] Filterable and gaseous arsenic concentration in milligrams per dry standard cubic meter (mg/dscm) and grains per dry standard cubic foot (gr/dscf). Dry standard conditions: 760 mm Hg (29.92 in. Hg), 20°C (68°F), and 0 percent water content.

[b] Slag skim only.

generated by the malfunctioning primary hood draft contributed to the higher arsenic concentrations observed during the second cycle test.

During the specific mode tests, filterable arsenic concentrations ranged from 4.98 mg/dscm (0.002 gr/dscf) to 9.01 mg/dscm (0.004 gr/dscf), and corresponding emission rates ranged from 0.99 kg/h (2.18 lb/h) to 1.98 kg/h (4.35 lb/h). Gaseous arsenic concentrations ranged from 0.24 mg/dscm (0.0001 gr/dscf) to 4.72 mg/dscm (0.002 gr/dscf) and the corresponding emission rates ranged from 0.05 kg/h (0.11 lb/h) to 0.99 kg/h (2.18 lb/h).

Table D-5 presents total arsenic emission factors in units of pounds of arsenic emitted per ton of copper produced. The total arsenic emitted value for each run was calculated by adding the filterable and gaseous fractions (in milligrams), using this value to calculate the concentration and mass emission rate (in pounds per hour), and then multiplying the mass emission rate by the time of the test (in hours).

Arsenic emission factors for the total cycle tests ranged from 0.03 lb/ton to 0.20 lb/ton. Arsenic emission factors for specific mode Tests PASM-1 and -2 were 0.07 lb/ton and 0.12 lb/ton, respectively. For Test PASM-3, which was run only during slag skimming operations, the arsenic emission factor was 0.02 lb/ton of copper produced. During this test, a total of 7.25 ladles of slag were skimmed from the converter. Based on information supplied by ASARCO, each ladle contains 12 to 15 tons of slag. Therefore, between 87 and 109 tons of slag were skimmed, which yields a skimming emission factor of about 0.025 pound of arsenic per ton of slag skimmed.

Table D-5. DEVELOPMENT OF ARSENIC EMISSION FACTORS

Converter cycle No.	Test I.D.	Date (1983)	Tons copper produced[a]	Total[b] arsenic, lb	Emission factor, lb arsenic/ton copper produced
1 Charge No. 79	PATC-1	1/18-19	150	9.48	0.06
	PASM-1			10.80	0.07
2 Charge No. 80	PATC-2	1/20	120	24.27	0.20
	PASM-2			14.32	0.12
3 Charge No. 81	PATC-3	1/22	150	4.78	0.03
	PASM-3[c]			2.61[c]	0.02[c]

[a] Information obtained from ASARCO converter operation logs.

[b] Total arsenic obtained by adding the filterable and gaseous fractions (in milligrams), calculating the concentration and subsequent mass emission rate (in pounds per hour), and multiplying the mass emission rate by the time of test (in hours).

[c] Slag skimming only.

APPENDIX E

DEMONSTRATED CONTROL DEVICE PERFORMANCE TO ACHIEVE THE LIMIT FOR CONVERTER SECONDARY EMISSIONS

DEMONSTRATED CONTROL DEVICE PERFORMANCE
TO ACHIEVE THE LIMIT FOR CONVERTER
SECONDARY EMISSIONS

E.1 INTRODUCTION

This appendix presents emission test data on fabric filter control device performance in the steel making industry and compares these data to secondary (fugitive) emission streams from copper converter operations. The EPA has collected test data on the performance of fabric filters collecting particulate emissions from electric arc furnaces (EAF's) and argon-oxygen decarburization (AOD) vessels for developing new source performance standards for the steel industry. The use of fabric filters in the steel industry and design specifications of these control devices are discussed in Sections I-E.2 and I-E.3. Characteristics of particulate emissions from EAF's and AOD vessels are compared with secondary emission gas streams from copper converters in Section I-E.4.

E.2 APPLICATION OF FABRIC FILTER CONTROL DEVICES IN THE STEEL INDUSTRY[1]

Fabric filter control devices are used in the steel industry to control emissions from EAF's and AOD vessels. EAF's are refractory lined, cylindrical vessels made of heavy welded steel plates and having a bowl-shaped hearth and removable dome-shaped roof. Scrap metal is melted in EAF's by three graphite (or carbon) electrodes that are lowered into the vessel through ports in the roof. AOD vessels are used in some steel plants to refine steel that was melted in an EAF. Argon, oxygen, and/or nitrogen are introduced in various proportions and stages of the "heat" to control the metallurgical reactions. Process emissions occur during the melting and refining stages and can be collected through direct-shell evacuation (on EAF's) or close fitting hoods that are ducted to fabric filters. Secondary (fugitive) emissions occur during the charging and tapping stages. Secondary emissions are collected through hooding or building evacuation systems and vented to a fabric filter. This same control device may also control process emissions.

E.3 FABRIC FILTER DESIGN SPECIFICATIONS

Design specifications reported for 21 fabric filter control devices used to control particulate emissions from EAF's and AOD vessels are presented in Table E-1. Design parameters presented are: (1) type of fabric filter (positive or negative pressure); (2) design gas flow; (3) number of compartments; (4) type of bag; (5) air-to-cloth ratio; (6) pressure drop; (7) gas temperature; and (8) type of cleaning mechanism. Not all of the information was available for all plant locations.

Positive pressure fabric filters force exhaust gas through the filter media using a fan situated between the collection duct and the fabric filter. Maintenance and filter bag inspection are easier than with negative pressure units because the bag compartments are not air-tight and can be entered while the unit is in service (if the gas is not too hot for personnel safety). Particle-laden gas is drawn through the filter bags so that the particles are retained on the fabric; the cleaned air is then vented to atmosphere through louvers or vents along the top of each compartment. Negative pressure type fabric filters use a fan on the clean air side of the control device to pull air through the bags. Bag compartments must be kept air-tight, and so inspection for defective bags requires the compartment to be taken off-line. The advantage of negative pressure fabric filters is that they require less fan maintenance and less operating horsepower than the positive pressure type. New fabric filter control devices installed on EAF's are generally the positive-pressure type because of their lower capital costs and the simple inspection procedures for detecting damaged bags.[2]

The design gas flows of the 21 fabric filters presented in Table E-1 range from 91,000 to 1,750,000 acfm, with an average of about 500,000 acfm. The filters utilize a multiple compartment design, with bags constructed of polyester fabric. Air-to-cloth ratios range from 1.95 to 5.5, and operating pressure drops across the devices range from 1.2 to 11 inches of water. Maximum inlet gas temperatures, available for only two plant locations, are 210°F (99°C) and 275°F (135°C). Two bag cleaning methods are used - reverse air flow and mechanical shaking. The reverse air flow mechanism collapses the filter bags, while the shaker mechanism physically shakes the dust off the bags.

E.4 GAS STREAM CHARACTERISTICS

Table E-2 presents a summary of particulate emissions data for fabric filter control devices used for EAF's and AOD vessels. Eight of the fabric filters are the positive pressure type and three are the negative pressure type. The outlet concentrations for the positive pressure EAF/AOD fabric filters range from 0.0002 to 0.0046 gr/scf. Negative pressure fabric filter outlet concentrations range from 0.0005 to 0.0029 gr/scf. Hence, fabric filter control devices applied to EAF/AOD furnaces have demonstrated the ability to achieve a 0.005 gr/dscf emission limit. The performance of fabric filters applied to EAF's and AOD vessels is compared to the performance of similar devices on copper converter secondary gas stream emissions by examining inlet grain loading data and the size distributions of the particulate emissions in these two types of gas streams.

Average inlet particulate concentrations were measured for three of the EAF/AOD fabric filter control devices and ranged from 0.0408 to 0.1068 gr/scf. The particulate concentration measured for the ASARCO-Tacoma No. 4 copper converter secondary emission gas stream was 0.039 gr/scf.[3] The inlet loading to the fabric filter at the ASARCO-El Paso fabric filter control device was only 0.0217 gr/scf.[4] Thus, based on these tests, the inlet grain loading in a copper converter secondary emission gas stream is slightly lower than the inlet loading in an EAF or AOD vessel gas stream.

A summary of particle size distribution data obtained for secondary emissions from EAF's and AOD vessels and for secondary emissions from copper converters is presented graphically in Figures E-1 and E-2.[5-9] The ASARCO-Tacoma copper smelter data were obtained using an Andersen III cascade impactor. This particulate sampling method was also used at

Table E-1. EAF AND AOD VESSEL FABRIC FILTER DESIGN SPECIFICATIONS[a]

Plant	Fabric Filter Pressure Type	Design Gas Flow (acfm)	No. of Compartments	Type of Bag	Air-to-cloth ratio	Pressure Drop (in. H_2O)	Gas Temp.	Type of Cleaning
A	Positive	460,000	12	Type 55 Dacron®	3.2	3.5-4.1	--	--
B No. 3	Negative	132,000	14	Dacron®	2.37	4-11	--	Shaker
B No. 4	Negative	91,000	--	Dacron®	2.69	4-11	--	Shaker
C	Negative	150,000	--	Polyester	4.5	2-7	--	RAF
D	Positive	425,000	--	Polyester	--	5.7	--	RAF
E	Positive	420,000	9	Dacron®	2.82	--	Max 99°C (210°F)	RAF
F	Positive	740,000	60	--	2.33	--	--	Shaker
G	Positive	400,000	6	--	2.60	1.2-2.4	--	--
H Canopy Hoods	Positive	345,000	--	--	4.1	--	--	--
I Canopy Hoods	--	700,000	14	Dacron®	--	--	--	Shaker
J	--	945,000	--	Nomex®	3.1	3-7.5	--	Shaker
K	Positive	900,000	--	Polyester	2.93	--	Max 135°C (275°F)	RAF
L	Positive	420,000	--	--	2.8	7-9	--	RAF
M	Positive	1,750,000	--	--	3.4	3-5	--	Shaker
N 1	Positive	450,000	--	--	3.1	8-10	--	--
N 2	Negative	750,000	--	--	5.5	7-8	--	--
O		525,000			1.95	3 and 7	--	RAF
P	Positive	600,000	--	Polyester	2.65	4-6		Shaker
Q	Positive	300,000	2	Dacron®	2.68	2.5-6	--	RAF
R	Positive	675,000	12	Polyester	3.26	6-8		RAF
S	Negative	230,000	--	Dacron®	3.62	5-10	--	RAF

RAF = Reverse Air Flow

[a] Information obtained from Reference 1. Design specifications not available in Reference 1 are indicated by "--".

Table E-2. SUMMARY OF PARTICULATE EMISSION DATA FOR FABRIC FILTER CONTROL DEVICES USED FOR EAF AND AOD VESSELS[a]

	Plant	Average Inlet Concentration (gr/scf)	Outlet Concentration (gr/scf)	
			Range	Average
Positive Pressure Fabric Filter Control Devices	A	0.0408	0.0010-0.0021	0.0014
	D	--	0.0008-0.0017	0.0011
	E	--	0.0015-0.0018	0.0016
	F	--	0.0008-0.0011	0.0009
	G	--	0.0005-0.0046	0.0026
	H	--	0.0026	0.0026
	P	0.1068	0.0013-0.0018	0.0015
	Q	0.0731	0.0002-0.0004	0.0003
	Q	--	0.0030	0.0030
Negative Pressure Fabric Filter Control Devices	B No. 3	--	0.0005-0.0018	0.0011
	B No. 4	--	0.0021-0.0029	0.0026
	C	--	0.0011-0.0013	0.0012

[a] A full description of the plants tested can be found in Reference 1. Generally, emissions testing was performed over a full heat cycle using Method 5. Plants P and Q are based on AOD vessel emissions, other plants' emissions are from EAF's.

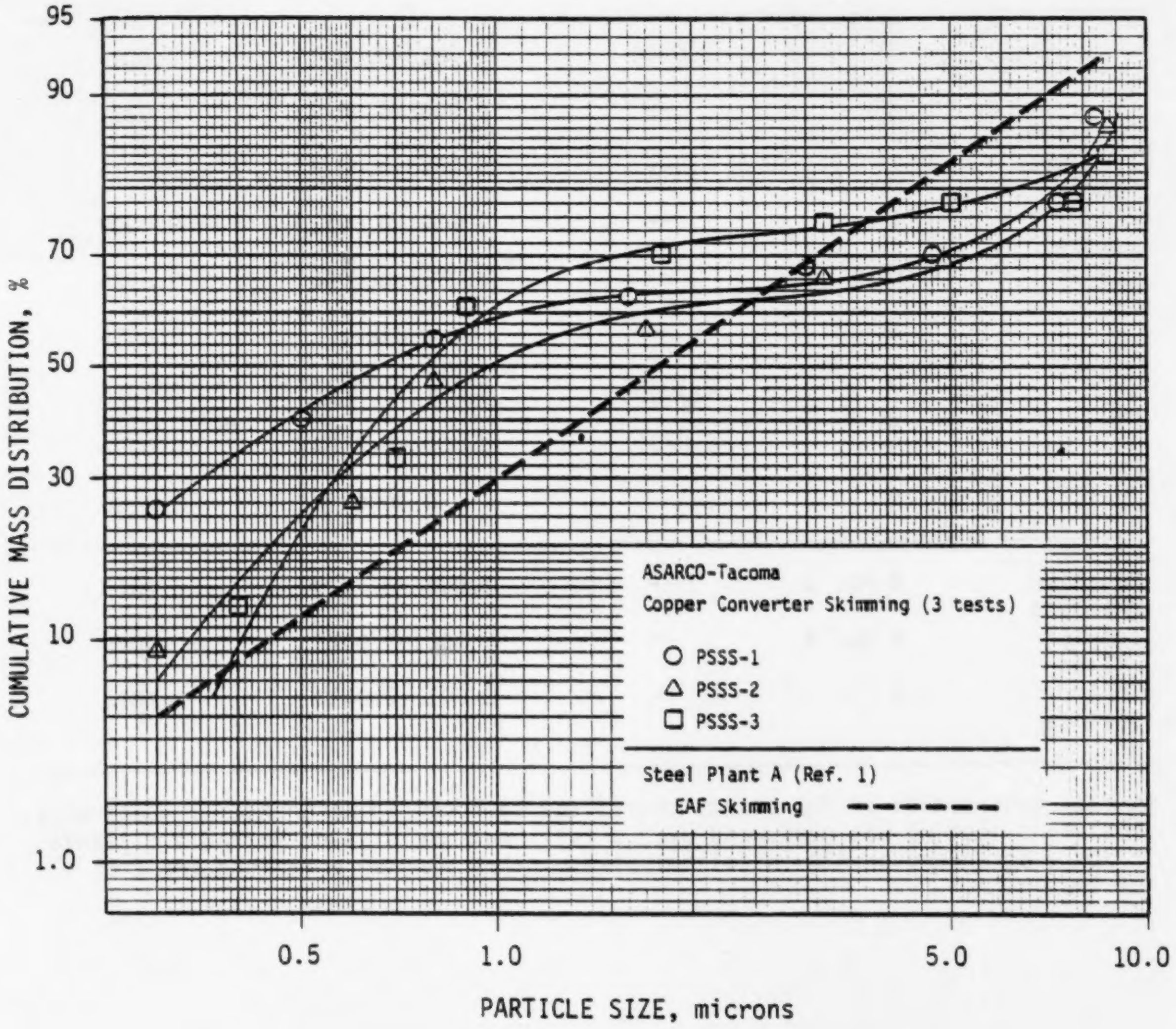


Figure E-1. Particle Size Distributions of Copper Converter and EAF Skimming Gas Streams

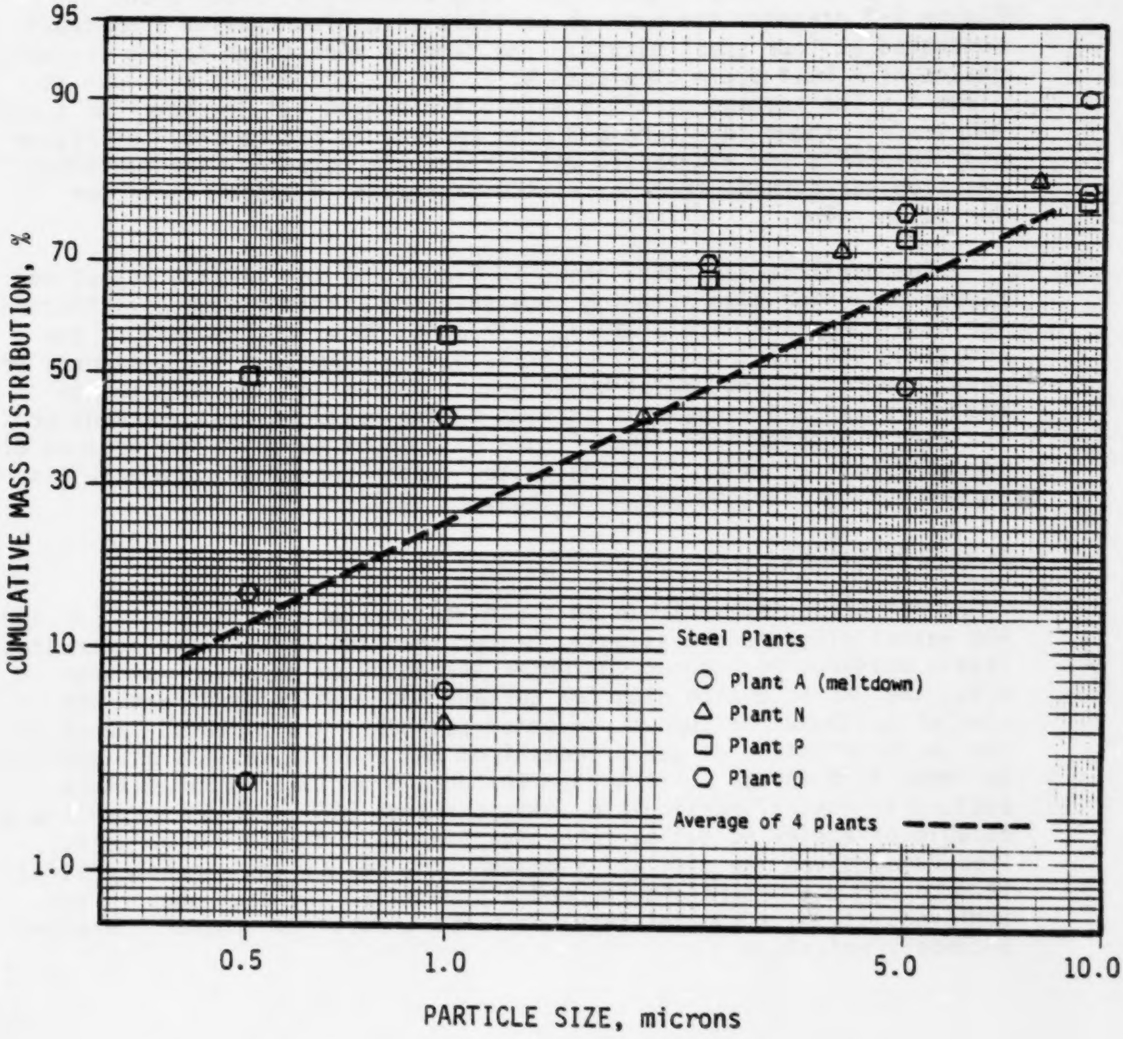


Figure E-2. Particle Size Distributions of EAF/AOD Vessel Gas Streams During Heat Cycles steel plant Q. At steel plant A, both Pilat and Brinks impactors were used. (The sampler types used at plants N and P are not specified in Reference 1.) Figure E-1 shows the particle size distribution measured in the air curtain secondary hood during the slag skimming mode at ASARCO-Tacoma in comparison to EAF slag skimming at steel plant A. Figure E-2 presents the average particle size distribution from tests conducted at four steel plants. The samples were taken during various phases of a heat cycle at plants N, P, and Q, and during meltdown at plant A. The average particle size distribution for the four EAF's and AOD vessels shown in Figure E-2 also appears in Figure E-3. In Figure E-3, the EAF's and AOD vessel gas streams are compared with secondary emission gas streams from the ASARCO-Tacoma No. 4 copper converter during charging.

The particle size data shown in Figure E-1 for EAF/AOD vessel and copper converter slag skimming show that the particle size distribution for both operations are similar, with about 90 weight percent of the emissions being composed of particles having diameters of 10 microns or less. In Figure E-2, about 80-90 weight percent of the particulate matter in EAF/AOD vessel gas streams during meltdown is 10 microns or smaller. In comparison, from Figure E-3, about 60-80 weight percent of the particulate matter from the tested copper converter secondary gas stream during charging was 10 microns or smaller.

E.5 CONCLUSIONS

Data presented indicate that particulate concentrations in EAF and AOD vessel offgases are slightly higher than the particulate concentration levels measured for copper converter secondary emission gas streams. Also, the particle size data for EAF and AOD vessel gas streams are similar to those for copper converter secondary gas streams. Hence, the characteristics of gas streams from EAF and AOD vessels are similar to those from copper converters. The data show that fabric filters applied to control particulate emissions from EAF's and AOD vessels are capable of achieving outlet concentrations less than 0.005 gr/dscf. Therefore, given the similarity between the gas stream characteristics from copper converters and EAF and AOD vessels, the data support the achievability of a control level of 0.005 gr/dscf for copper converter secondary emissions.

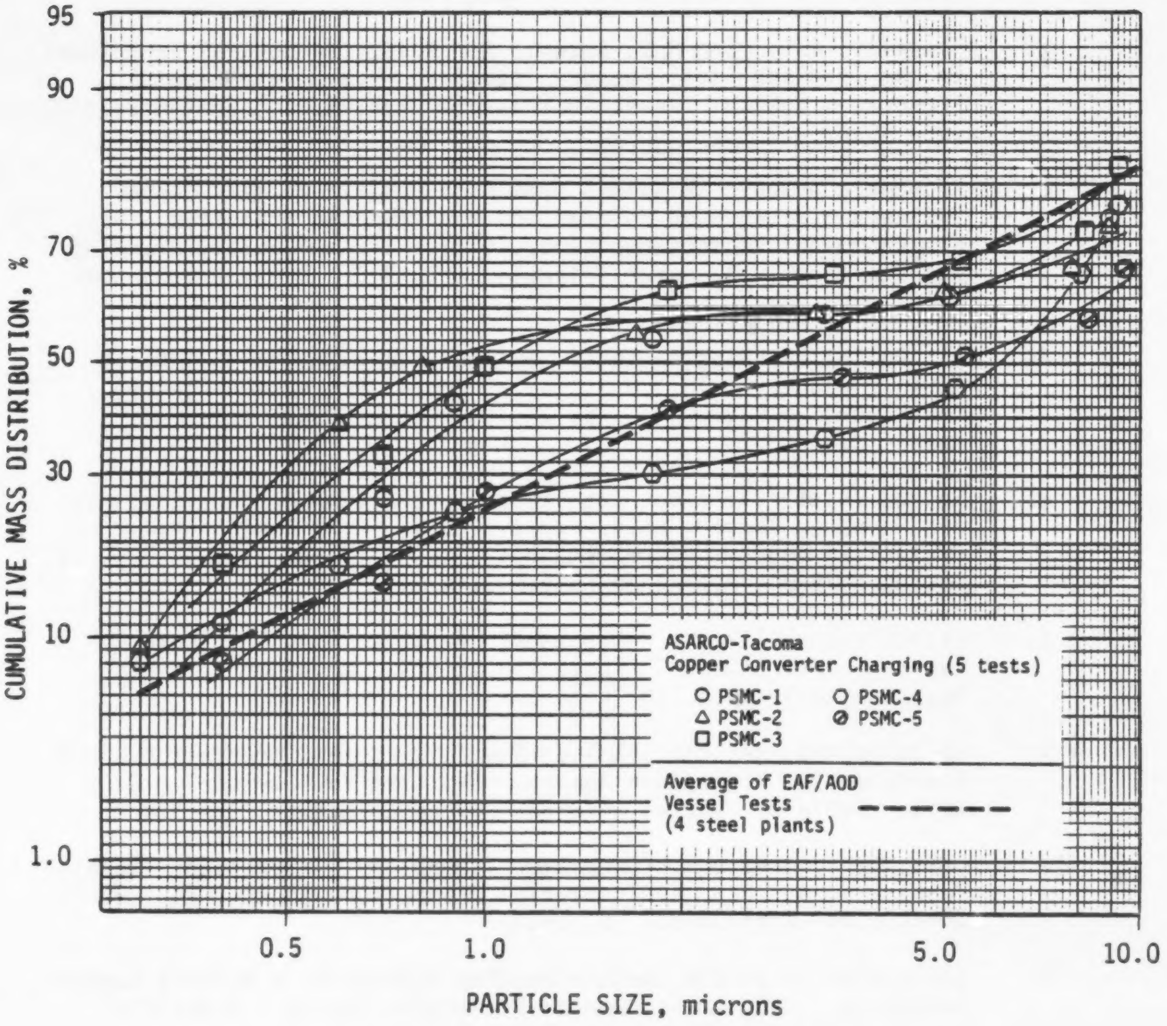


Figure E-3. Particle Size Distributions of Copper Converter Charging and EAF/AOD Vessel Meltdown Gas Streams

E.6 REFERENCES

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APPENDIX F

ECONOMIC IMPACT

APPENDIX F

ECONOMIC IMPACT

This section first presents an economic profile of the primary copper industry in general, and primary copper smelters in particular (Section F.1). The data presented in the economic profile is then used in an economic analysis of the industry (Sections F.2 and F.3). The economic profile focuses on several primary copper smelter industry characteristics, such as: number and location of smelters, copper supplies, copper demand, competition, substitutes, and prices.

F.1 INDUSTRY ECONOMIC PROFILE

F.1.1 Introduction

Copper's utility stems from its qualities of electrical and thermal conductivity, durability, corrosion resistance, low melting point, strength, malleability, and durability. Principal uses are in transportation, machinery, electronics, and construction.

The Standard Industrial Classification Code (SIC) definition of the primary copper industry is the processes of mining, milling, smelting, and refining copper. The primary copper smelters are included in SIC 3331 (Primary Smelting and Refining of Copper). Copper-bearing ore deposits and substantial amounts of copper scrap provide the raw materials for these processes.

In addition to producing copper, the industry markets by-product minerals and metals that are extracted from the ore deposits, such as silver, gold, zinc, lead, molybdenum, selenium, arsenic, cadmium, titanium, and tellurium. Many of the companies that own primary copper facilities also fabricate copper. Many of these same companies are also highly diversified and produce other metals, minerals, and fuels.

The standard under consideration directly affects only one of the four primary copper processes, namely smelting. However, the other three related processes are an integral part of the ownership and economic structures of copper smelters and therefore must be considered in determining industry impact. Mining and milling processes supplying a smelter will be secondarily affected by a smelter impact because transportation costs to an alternate smelter will add a sizeable business cost. Transportation costs for concentrate are significant because only 25 to 35 percent of the concentrate is copper and the remaining 75 to 65 percent that is also being transported is waste material. The same interdependence between smelter and refinery is not as critical because the copper content after leaving the smelter is typically 98 percent.

Even if there were no business dependencies among the processes, the available financial data for smelters is aggregated in consolidated financial statements which makes smelter data difficult to isolate. Thus, an economic analysis of copper smelters must be cognizant of the economic connection backward to the mines and forward through the refining stage.

F.1.2 Market Concentration

Fifteen pyrometallugical copper smelters exist in the United States. Copper is also produced in limited amounts by various hydrometallurgical methods which by-pass the smelting stage. These hydrometallurgical facilities are not being considered in the standard setting process. The 15 copper smelters have a capacity* of 1,722,600 megagrams** of copper. The hydrometallugical processes have a capacity of roughly 10 percent of the copper smelters' capacity.

Table F-1 shows that the vast majority (approximately 89 percent) of smelting capacity is located in the southwestern States of Utah, Nevada, New Mexico, Arizona, and Texas, close to copper mines. The location is largely dictated by the need to minimize shipping distances of concentrates, which are normally 25 percent to 35 percent copper.

The 15 U.S. copper smelters are owned by 7 large companies. All 7 companies are integrated in that, to various degrees, they own some mining and milling facilities which produce copper concentrates for the smelters. Several smelters, apart from the concentrates from their own mines, buy additional concentrates from other mining and milling producers, smelt and refine the copper, and then sell it. This practice is referred to as custom smelting. Other smelters process (smelt and refine) the concentrates, and return the blister copper to mine owners for them to sell, a practice referred to as tolling. Some smelters perform both toll and custom smelting.

It is general industry practice for companies to operate their smelters as service centers at low profit margins to the owned mines. This acts to shift profits of an integrated operator to the mines, where depletion allowances exist. This maximizes profit to the overall operation. An implication of this policy is that the impact on profits from swings in copper prices is frequently manifest at the mines more than the smelters.

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*Capacity is not a static measure of a smelter since capacity can vary, for example, according to the grade of copper concentrates processed.

**1 megagram = 1.1 short tons.

Table F-1. SMELTER OWNERSHIP, PRODUCTION AND SOURCE MATERIAL ARRANGEMENTS[a]

Smelter Name and Location	Ownership	1980 Rated[1] Capacity (Mg)	1979 Production (Mg)	1980 Production (Mg)	Material Arrangements		1979	1980
Tacoma, WA	ASARCO, Inc.	91,000	61,000[2]	42,700[2]	Integrated	-	31%	20%
Hayden, AZ		182,000	96,000	59,000	Custom	-	25%	44%
El Paso, TX		91,000	85,000	47,300	Toll	-	44%	36%
Copperhill, TN	Cities Service Co.	13,600	12,900[3]	10,000[3]	Integrated[b]	-	100%	100%
White Pine, MI	Copper Range Co. Subsidiary of The Louisiana Land Exploration Co.	52,000	39,770[4]	32,500[4]	Integrated	-	100%	100%
Miami, AZ	Inspiration Consolidated Copper Company	136,000	124,070[5]	107,400[5]	Integrated Toll	- -	35% 65%	58% 42%
McGill, NV	Kennecott Corp.	45,000			Integrated	-	100%	90%
Garfield, UT		254,000	296,000[6]	259,300[6]				
Hayden, AZ		71,000						
Hurley, NM		73,000[c]	56,360	46,100	Toll	-		10%
Magma (San Manuel, AZ)	Newmont Mining	181,000	145,900[7]	98,000[7]	Integrated Toll	- -	100%	100%
Douglas, AZ	Phelps Dodge Corp.	115,000			Integrated	-	-	75%
Ajo, AZ		64,000	283,000[8]	324,100[8]	Custom	-	-	
Morenci, AZ		191,000			Toll	-	-	25%
Hidalgo, NM		163,000	91,000					
Total Production		1,722,600[d]	1,291,000	1,026,420	Integrated	-		73%
Operating Rate			(74.9%)	(59.6%)	Custom	-		6%
					Toll	-		21%

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[a] Information primarily from corporate 10-K reports to the Securities and Exchange Commission.

[b] Estimate based on total copper sales for Cities Service minus the sales of its Arizona mines.

[c] Estimated to expand to 110,000 tons.

[d] Rated capacity excluding Anaconda smelter which was closed in 1980 (rated at 180,000 Mg).

Table F-1 lists the smelters, their corporate owners, capacities, 1979 and 1980 production amounts, and the distribution of integrated, custom, and toll smelting. Total production figures and the corresponding operating rates shown in Table F-1 are compiled from corporate reports. Figures in Table F-1 are adjusted to exclude capacity and production for the Anaconda smelter, which was closed in 1980. For 1979, the table shows a 74.9 percent operating rate. For 1980, the table shows that the industry operated at 59.6 percent of capacity. Production was down for 1980 due to an industry strike. Following the strike in 1980, production improved in 1981 to 1,380 gigagrams, for a capacity utilization rate of 80 percent.[9] Preliminary figures for 1982 from the Bureau of Mines show a decline in primary copper smelter production to 1,020 gigagrams, for a capacity utilization rate of about 59 percent.[10]

The 3 largest companies account for 78 percent of the entire smelting capacity. Phelps Dodge Corporation has the largest smelting capacity, followed by Kennecott Corporation and then ASARCO. The remaining 4 companies each have 1 smelter and in order of size are Magma (Newmont), Inspiration, Copper Range, and Copperhill (Cities Service).

The table also shows that 73 percent of total 1980 smelter production was from concentrate from integrated arrangements. Of the remaining concentrate, 21 percent was smelted on a toll basis and 6 percent smelted on a custom basis. Three of the 8 companies process only their own copper concentrates.

F.1.3 Total Supply

Copper resources are defined as deposits which can be profitably extracted at a given price. Various estimates of U.S. copper resources show amounts ranging from 61.8 teragrams to 99.1 teragrams.* The capability of copper resources to meet future demand is dependent upon several factors; a principal one being the rate of growth in demand. The U.S. Bureau of Mines estimates that copper demand will grow at an annual growth rate of 3.0 percent to the year 2000 and that 30 percent of the demand will be supplied by scrap. Therefore, the likely primary copper demand over this period would be 55 teragrams compared with 92 teragrams of resources.[11] Consequently, U.S. supply appears adequate to the year 2000. Beyond the year 2000, demand is expected to strain supply sources. However, increased uses of old scrap and possible exploitation of sea nodules can supplement on-shore mining. In addition, microminiaturization, copper cladding, and other conservation methods will be more widely used to extend the supply of copper.

F.1.3.1 Domestic Supply. Primary refined copper output alone does not depict the entire supply of copper that is available for consumption in the United States. A large portion of copper scrap does not need to be resmelted or re-refined and is readily available for consumption. Copper is a durable material and, if it is unalloyed or unpainted, etc., it can be reused readily. Otherwise, it is resmelted or re-refined as described earlier. The ready availability of copper scrap as a secondary source of supply tends to be a stabilizing influence on producers' copper prices.

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*Teragram is 1.1 million short tons.

The total supply of copper available for consumption in any one year is therefore comprised of refined U.S. production, scrap not re-refined, net imports, and any changes in inventory of primary refined production from one year to the next.

The refined copper production in 1981 comprised 70.4 percent of total copper consumed in the United States; scrap not re-refined accounted for 32.0 percent and net refined imports 10.6 percent (total exceeds 100 percent due to stock changes).[12] Between 1970 and 1981, 67 percent of U.S. copper demand, excluding stock changes, was met from domestic mine production; 21 percent was from old scrap, and 12 percent from net imports. During these years, total U.S. demand for copper averaged 2,012,000 megagrams per year. Of this amount, 1,337,000 megagrams was from domestic production, 427,000 megagrams from scrap, and 248,000 megagrams from net imports.

Another statistic for describing the importance of scrap is to add the three stages (smelting, refining from scrap, and reuse of scrap) at which scrap can enter the production process, and compare the figures to total copper consumption. In 1981 the percentage of total consumed copper from scrap was 47.7, roughly the same as in recent years.

The 1981 refined copper production level was 1,956,400 megagrams. Although the average for the past several years has shown some improvement, total refined copper production has not returned to the 1973 peak level.

F.1.3.2 World Copper. According to the Bureau of Mines, the world reserve of copper in ore is estimated at 494,000 gigagrams of copper. In addition, an estimated 1,333,000 gigagrams of copper are contained in other land-based resources, and another 689,000 gigagrams in seabed nodules. The United States accounts for 19 percent of known copper reserves and 26 percent of other land-based copper resources.[13]

The United States is the leading copper producing and consuming country. Other major copper mining countries include: Chile, the U.S.S.R., Canada, Zambia, Zaire, Peru, and Poland. Although its copper mining activity is quite small, Japan is among the three largest countries in terms of copper smelting and refining. In 1981 the U.S. produced 18.8 percent of the world's mine production of copper, 16.5 percent of the smelter production, and 22.2 percent of the refinery production. The consumption of the world's refined copper by the U.S. amounted to about 21 percent. Table F-2 shows U.S. production, world production, and the U.S. percent of world production for the years 1963 through 1981. Although the U.S. is essentially maintaining its consump-

Table F-2. UNITED STATES AND WORLD COMPARATIVE TRENDS IN COPPER PRODUCTION: 1963-1981[16,17]

(Gigagrams)

Years	Mine Production of Copper (Copper Content)			Smelter Production of Copper			Production of Refined Copper		
	U.S.	World	U.S. as Percent of World	U.S.	World	U.S. as Percent of World	U.S.	World	U.S. as Percent of World
1963	1100.6	4624.3	23.8	1176.3	4634.8	25.4	1709.5	5399.7	31.7
1964	1131.1	4798.6	23.6	1214.2	4851.4	25.0	1805.7	5739.0	31.5
1965	1226.3	4962.7	24.7	1300.9	5024.4	25.9	1942.1	6058.5	32.1
1966	1296.5	5215.9	24.9	1330.3	5167.0	25.7	1980.7	6322.2	31.3
1967	865.5	5057.6	17.1	782.3	4891.0	16.0	1384.9	6000.5	23.1
1968	1092.8	5456.5	20.0	1148.9	5507.8	20.9	1668.3	6658.6	25.1
1969	1401.2	5951.2	23.5	1438.3	5972.9	24.1	2009.3	7199.8	27.9
1970	1560.0	6387.3	24.4	1489.0	6309.5	23.6	2034.5	7577.8	26.8
1971	1380.9	6473.9	21.3	1360.8	6380.0	21.3	1780.3	7377.8	24.1
1972	1510.3	7071.5	21.4	1533.5	7003.2	21.9	2048.9	8068.0	25.4
1973	1558.5	7591.4	20.5	1582.1	7445.5	21.2	2098.0	8497.3	24.7
1974	1445.7	7885.6	18.3	1424.2	7933.6	18.4	1938.3	8851.5	21.9
1975	1282.2	6968.2	18.4	1357.5	7535.4	18.0	1610.7	8402.0	19.2
1976	1456.6	7525.3	19.4	1438.5	7839.6	18.3	1736.7	8322.3	20.9
1977	1364.4	7755.8	17.6	1346.8	8136.9	16.6	1706.9	8649.8	19.7
1978	1357.6	7618.3	17.8	1343.0	8017.5	16.8	1869.2	8791.9	21.3
1979	1443.6	7674.4	18.8	1396.0	8045.6	17.4	2013.8	8903.1	22.6
1980	1181.1	7656.3	15.4	1053.3	7938.9	13.3	1726.0	8971.0	19.2
1981	1538.2	8171.1	18.8	1377.7	8324.7	16.5	2037.6	9184.4	22.2
Average Annual Compound Growth Rate (Percent)									
1963-1973	3.54	5.08	-	3.01	4.85	-	2.07	4.64	-
1964-1974	2.48	5.09	-	1.61	4.77	-	0.71	4.43	-
1971-1981	1.09	2.36	-	0.12	1.03	-	1.36	2.21	-

Note: One gigagram = 1,000 megagrams. One megagram (1,000 kilograms) equals 1.102311 short tons (907.185 kilograms = 2000 pounds avoirdupois, where one pound avoirdupois equals 0.453592 kilogram or 453.5924 grams).

tion and production levels, world consumption and production is increasing. As a result, the U.S. share of world consumption and production shows a relative decrease.

In 1981 world consumption of refined copper rose 9 percent to 9,440 gigagrams.[14] Stocks of refined copper in the market economy countries increased 5 percent to 1,100 gigagrams.[15]

F.1.4 U.S. Total Consumption Of Copper

Total copper consumed in the United States over the last 12 years has fluctuated considerably but shows an overall upward trend. However, copper consumption has not returned to its 1973 peak. This conclusion is derived from data on copper consumption from refineries and copper consumption from refineries plus scrap.

Table F-3 shows each set of data for the years 1970 through 1981. The 5-year averages in gigagrams for copper consumption from refineries has increased by 6.9 percent (1972 through 1976 is 1,891.9 and 1977 through 1981 is 2,021.5.). Five-year scrap consumption has shown an increase of 5.1 percent, from 848.6 gigagrams for the 1972 to 1976 period, to 892.3 gigagrams for the 1977 to 1981 period. There are signs that the consumption of scrap has begun to increase over the last few years.

The Bureau of Mines forecasts a long-range overall consumption growth rate to the year 2000 of 3.0 percent per year. The combined 3.0 percent growth rate is composed of a 2.4 percent growth rate for primary copper, and a 4.8 percent growth rate for secondary copper.[19]

F.1.4.1 Demand By End-Use. Refined copper and copper scrap are further processed in a number of intermediate operations before the copper is consumed in a final product. Refined copper usually consists of one of the following shapes: cathodes, wire bars, ingots, ingot bars, cakes, slabs, and billets. These shapes plus the copper scrap then go to brass mills, wire mills, foundries, or powder plants for subsequent processing. The copper is frequently alloyed and transformed into other shapes such as sheet, tube, pipe, wire, powder, and cast shapes. Ultimately, the copper is consumed in such shapes in five market or end-use categories. The Copper Development Association, Inc. uses the following categories: building construction, transportation, consumer and general products, industrial machinery and equipment, and electrical and electronic products.

Table F-4 shows the demand for copper in each of these five markets over the 12-year period 1970 through 1981. The total figures for these five markets will not equal the total consumption figures of Table F-3 due to the effects of stock changes and imports on fully fabricated copper products.

A look at the 5-year average demand shows that there has been an increase in three out of the five markets. The building industry

Table F-3. U.S. COPPER CONSUMPTION[18]

(Gigagrams)[a]

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981[b]
Consumption of Refined Copper	1859.8	1833.0	2029.5	2220.6	1998.6	1398.9	1811.7	1989.2	2196.5	2164.1	1876.3	1890.6
Consumption of Scrap[c]	811.6	859.5	946.0	956.4	878.0	662.4	800.4	847.6	881.1	984.3	860.0	888.6
Total Consumed Copper	2671.4	2692.5	2975.5	3177.0	2876.6	2061.2	2612.2	2836.8	3077.5	3148.4	2727.3	2779.1
% of Total as Scrap	30.4	31.9	31.8	30.1	30.5	32.1	30.6	29.9	28.6	31.3	31.5	32.0
1972-1976 and 1977-1981 averages for consumption refined			1891.9					2021.5				
1972-1976 and 1977-1981 averages for consumption of scrap			848.6					892.3				
1972-1976 and 1977-1981 averages for total copper consumption			2740.5					2913.8				

[a] 1 gigagram = 2.2 million pounds.

[b] Preliminary.

[c] Without having to be refined again.

Table F-4. U.S. COPPER DEMAND BY MARKET END USES[20]

(Gigagrams)[a]

Market	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981[b]
Building Constr.	748	830	923	998	795	634	780	888	956	951	774	816
Transportation	267	307	345	402	332	265	372	412	422	388	270	310
Consumer and General Products	369	358	417	413	402	316	328	340	388	420	342	376
Industrial Machinery and Equipment	560	540	601	640	563	404	483	518	551	565	501	537
Electrical and Electronic Products	717	742	773	838	766	541	683	767	801	853	754	774
Total	2661	2777	3059	3291	2858	2161	2646	2925	3118	3177	2641	2813
5-Year Average Demand[c]												
Building Construction			826.0					877.0				
Transportation			343.4					360.4				
Consumer and General Products			375.2					373.2				
Industrial Machinery and Equipment			538.2					534.4				
Electrical and Electronic Products			720.2					789.8				

[a] 1 Gigagram = 2.2 million pounds.

[b] Preliminary.

[c] (1972-1976, and 1977-1981).

market sales showed a gain of 6.2 percent. The transportation market shows a gain of 5.0 percent. An increase of 9.7 percent occurred in the electrical and electronic product markets. The demand for electrical equipment has risen because of increased emphasis on safety, comfort, recreation, and a pollution-free environment. Automation, including the use in computers, has also boosted the use of copper.

Substitution of other materials, coupled with the recession, has caused the slight drop of less than 1 percent in the consumer and general products markets. The 1 percent decline in the industrial machinery and equipment market is largely due to the impact of the recession.

The Bureau of Mines estimates that the most growth in copper demand will occur in the electrical and electronic products industries, consumer and general products, and building construction. Copper is an important metal in electric vehicles. If electric vehicles become popular, this would be a source of increased demand for copper. General Motors plans to produce an electric family car for mass marketing in the mid-1980's. A conventional internal combustion automobile contains from 6.8 to 20.4 kg of refined copper, whereas electric vehicles use much more copper. The Copper Development Association estimates range from 45.4 kg to 90.7 kg, with an average nearer to 45.4 kg.[21]

Another potential area for growth is in the solar energy industry. Presently, the extent of this sector is relatively modest, consuming approximately 4,500 Mg/yr of copper in the U.S. However, consumption in this sector has the potential to climb considerably.

In addition, the U.S. military demand for copper is expected to increase. Increased military expenditures will have a significant impact on copper demand because copper is an important element in modern electronic weaponry. During heavy rearmament periods the military demand for the metal has reached 18 percent of copper mill shipments. Although military demand is not expected to return to the record high 18 percent level, analysts do expect a large increase in military requirements for copper from the low level in 1979 of less than 2 percent.[22]

The demand picture in the United States may receive a boost from the federal government. The government is committed to eventually acquire 1.1 gigagrams of copper for its currently depleted strategic stockpile. The previous stockpile was largely depleted in 1968; the final sale was in 1974 after copper prices had soared. Further Congressional action is necessary to implement and fund the purchase plan.

F.1.4.2 Substitutes. Substitutes for copper are readily available for most of copper's end uses. Copper's most competitive substitute is aluminum. Other competitive materials are stainless steel, zinc, and plastics. Aluminum, because of its high electrical conductivity, is used extensively as a copper substitute in high voltage electrical transmission wires. Aluminum has not been used as extensively in residential wiring because of use problems, and minimal savings.

Aluminum is also potentially a substitute for copper in many heat exchange applications. For example, automobile companies are still experimenting with the use of aluminum versus copper in car radiators. When copper prices are high, or copper supply is limited, cast iron and plastics are used in building construction as a copper pipe substitute. A relatively new substitute for copper is glass, which is used in fiber optics in the field of telecommunications.

F.1.5 Prices

Numerous factors influence the copper market, and thus the price of refined copper. These factors include: production costs, long-run return on investment, demand, scrap availability, imports, substitute materials, inventory levels, the difference between metal exchange prices and the refined price, and federal government actions (e.g., General Services Administration stockpiling and domestic price controls).

Among the many published copper price quotations, two key price levels are: 1) those quoted by the primary domestic copper producers and 2) those on the London Metal Exchange and reported in Metals Week, Metal Bulletin, and the Engineering and Mining Journal. The producers' price listed most often is for refined copper wirebar, f.o.b. refinery. The London Metal Exchange price, referred to as LME, is also for copper sold as wirebar. The LME is generally considered a marginal price reflective of short-term supply-demand conditions, while the producer price is more long-term and stable and often lags the LME price movement.

Copper is also traded on the New York Commodity Exchange (Comex). Arbitrage keeps the LME price and the Comex price close together (with minor price differences due to different contract terms on the two exchanges, and a transportation differential).

Table F-5 shows the LME, the U.S producer price, and the U.S. producer price adjusted to a 1982 constant price for the years 1970 through 1982. Data were obtained from U.S. Bureau of Mines publications.

Several points can be observed from the table with respect to the LME price versus the U.S. producer price: (1) the LME price has had wider swings than the producer price; (2) in the past when both prices are relatively high, the LME price has been considerably higher than the producer price, while during relatively low price periods, the producer price has been moderately higher than the LME price; and (3) in recent years a marked change appears to be taking place away from a two-price system and toward a one-price system, with the difference between the LME and the U.S. producer price accounted for only by a transportation differential. These earlier situations had reoccurred repeatedly over the past 20 years. One other point about the table should be mentioned, although unrelated to the relationship of the

Table F-5. AVERAGE ANNUAL COPPER PRICES[23,24,25]
(cents per kg)[a]

Year	LME[b]	U.S Producer Price[c]	U.S. Producer Price 1982 Constant Price[d]
1970	138.6	128.0	290.9
1971	106.7	114.4	248.7
1972	106.7	112.6	234.6
1973	178.0	130.9	256.7
1974	204.8	170.1	303.8
1975	123.4	141.2	231.5
1976	140.6	153.1	239.2
1977	130.7	147.0	216.2
1978	136.2	146.3	200.4
1979	198.2	205.3	259.9
1980	218.5	225.3	262.0
1981	174.7	187.2	199.1
1982[e]	147.4	162.8	162.8

[a] To convert from cents/kg to cents/lb, multiply by 0.454.

[b] London Metal Exchange "high-grade" contract.

[c] U.S producer price, electrolytic wirebar copper, delivered U.S destinations basis.

[d] Adjusted to 1982 constant price by applying implicit price deflator for gross national product (1972 = 100).

[e] Preliminary.

LME to the producer price. The producer price has not kept pace with general inflation.

In theory, the U.S. producer price should be somewhat higher than the LME price since ocean transport costs must be incurred to get the refined copper to the U.S. However, this relationship appears to hold only during slack price periods. When LME prices are high, the producers do not raise their prices as much, which in theory appears contrary to profit maximization. Explanations offered for such behavior include: the producers' fear of long-run substitution for copper if the producers raised the price to the fabricators, high profits for integrated fabricators while reducing supply to nonintegrated fabricators, past fears of government stockpile sales that would reduce prices, and fear of the return of government intervention through price controls.

The cost of producing copper is one of the elements that influences the price of copper. Considerable data exist to validate the point that the long-run economic cost of producing copper is increasing.[26] During the early 1970's the capital costs per megagram of annual capacity for developing copper from the mine through refining stage were $2,000 to $2,500, and by the late 1970's had risen sharply to $7,200 to $7,700. Estimates are that a price of $2.76 per kg to $3.30 per kg for refined copper would be needed to support such new capital outlays.

The above costs are for conventional pyrometallurgical smelting. The newer smelting processes such as Noranda and Mitsubishi offer some capital cost savings at that stage due to lower pollution control costs. The hydrometallurgical processes also require less capital. However, the mining costs are the highest part of overall development costs for which limited cost saving techniques exist. The mine development costs in the U.S. have risen significantly, largely as a result of the shifting from higher to lower grades of available copper ores and sometimes remote locations that require infrastructure costs for towns, roads, etc.

In 1979, the Bureau of Mines analyzed 73 domestic copper properties to determine the quantity of copper available from each deposit and the copper price required to provide each operation with 0 and 15 percent rates of return. The Bureau estimates that a copper price of $4.56 per kg would be required if all properties, producing and nonproducing, were to at least break even. The average break-even copper price for properties producing in 1978, $1.46 per kg, was about equivalent to the average selling price for the year. At this price, analysts calculate that only 25 properties could either produce at break-even or receive an operating profit. Of these properties, only 12 could receive at least a 15 percent rate of return.

Annual domestic copper production, from 1969 to 1978, averaged 1,337,000 megagrams. According to this study, in order to produce at this level and receive at least a 15 percent rate of return, a copper price of $1.81 per kg is required. If the United States were to produce the additional 248,000 megagrams that were imported each year over this period, a copper price of $1.94 would be necessary.[27] The report concludes that increases in copper prices are required in order for many domestic deposits to continue to produce.

It has been suggested that long-term potential for higher prices, plus the high cost of new capacity are significant reasons for the increased purchases several years ago of copper properties by oil companies. The reasoning is that oil companies need places for heavy cash flows, and diversification to other products is desirable. The oil companies reportedly can wait for expected copper price increases to obtain their return. Further, by purchasing existing facilities, rather than building new capacity, they avoid the escalating new capacity costs. However, more recently, some oil companies seem to be rethinking their investments in copper.

As shown below, U.S. oil (and gas) companies own or have major interests in many of the largest domestic copper producers:

1. Amax - Approximately 20 percent owned by Standard Oil of California
2. Anaconda - Owned by Atlantic Richfield Company (ARCO)
3. Cities Service - Also a primary copper producer
4. Copper Range - Owned by Louisiana Land and Exploration Company
5. Cyprus Pima Mining Company - Standard Oil Company (Indiana)
6. Duval - Owned by Pennzoil Company
7. Kennecott - Standard Oil of Ohio (British Petroleum)

These copper producers own or control a large portion of domestic copper reserves, mine production, and U.S. refinery capacity. Their investment in the copper industry is significant, and thus they must expect higher prices and profits in the future.

F.2 ECONOMIC ANALYSIS

F.2.1 Introduction

This section presents the economic analysis of the arsenic NESHAP for the 14 primary copper smelters. The fifteenth primary copper smelter (ASARCO-Tacoma) is not discussed in this analysis, because the company has announced its intention to close the smelter during 1985.

Two principal economic effects are analyzed. First, the ability of the smelters to pass pollution control costs forward to consumers, in the form of an increase in the price of copper. Second, the reduction in profits if part or all of the control costs cannot be passed forward in the form of price increases but must be absorbed by the copper producers. Section F.2.2 presents a summary of the results. Section F.2.3 presents the methodology. Section F.2.4 presents the impact on prices, Section F.2.5 presents the impact on profits, and Section F.2.6 presents a discussion of capital availability.

F.2.2 Executive Summary

In 1982 the copper producers experienced one of the worst years in recent history. During much of 1982 major segments of the industry were closed for sustained periods. Such a depressed situation cannot be used as the foundation to examine the long-term economic effects of the potential arsenic NESHAP. Therefore the economic analysis is based on a more normal condition for the industry. However, even under more typical conditions for the industry, six smelters may face significant financial impairment, and two additional smelters, Cities Service-Copperhill and Kennecott-McGill, appear to be likely closures. The control costs for the remaining six smelters appear affordable.

If each smelter attempts to pass control costs forward in the form of a price increase, the price increases would range from 0 percent to 15.2 percent, at an 80 percent capacity utilization rate, and depending on the regulatory alternative. For Alternative II the price increase would be 0 for every smelter, with one exception (Kennecott-McGill) that would have a large 15.2 percent price increase. For Alternative III the price increases would range from 0.2 percent to 6.3 percent. For Alternative IV the price increases are lower and would range from 0 to 1.3 percent. For Alternative III+IV the price increases would range from 0.2 percent to 7.6 percent. Competition will prevent the existence of such a broad variation, and therefore partial or complete absorption of control costs is more likely than a full pass forward of control costs.

If control costs are absorbed and profit margins reduced, again a broad range exists. At an 80 percent capacity utilization rate and a ten percent profit margin, for Alternative II the profit decrease would be 0 for every smelter, with one exception (Kennecott-McGill) that would result in a net loss. For Alternative III the profit decrease would range from 2.1 percent to 62.6 percent. For Alternative IV the profit decrease would be lower and would range from 0 percent to 12.8 percent. For Alternative III+IV the profit decrease would range from 2.1 percent to 75.4 percent.

Although the capital costs of the control equipment are not minor amounts, for most of the producers the capital cost would not present a major obstacle. For two of the producers, ASARCO and Phelps Dodge, the capital costs may present some difficulty but should not be an insurmountable financial obstacle.

F.2.3 Methodology

The purpose of this section is to explain in general terms the methodology used in the analysis. Each of the appropriate sub-sections explains the methodology in more detail. No single financial indicator is sufficient by itself to use for decision making purposes about the primary copper smelters. Therefore the methodology relies on several indicators which in total can be used to draw conclusions about the industry.

The methodology has three major parts. The first part is an analysis of price effects. The analysis of price effects introduces an upper limit on the problem and provides a benchmark to make evaluations on a relatively uncomplicated basis. A price increase represents the "worst case" from the viewpoint of a consumer of copper. The second major part of the methodology is an analysis of profit effects. The analysis of profit effects introduces a lower limit on the problem and is the "worst case" from the viewpoint of the firm. The individual characteristics of each smelter increase in importance and are incorporated to a greater extent. The third and final part of the methodology is an analysis of the availability of capital to purchase the control equipment.

Firms in the copper industry face a wide variety of variables that in the aggregate determine the economic viability of the firm generally, and a smelter specifically. The variables can be grouped into four broad categories. The categories are described here separately and in a simplified manner for discussion purposes. However, there is a close interrelationship among the four categories and changes in one will have implications for the others. The four broad categories that determine the economic viability of the smelter are described below.

1) Macroeconomic conditions. The two most prominent variables in this category are copper prices and copper demand. By-products and co-products represent a significant source of revenues for most copper operations. Therefore in addition to the price of copper, the price of by-products and co-products also influence an assessment of economic viability. Common by-products and co-products of copper production include: gold, silver, molybdenum, and sulfuric acid. Other by-products include selenium, tellurium, and antimony. For ease of presentation and in order to present a conservative analysis, by-products and co-products are not considered explicitly in the analysis.

Another important variable, though somewhat less visible, is government actions, such as: federal and state tax policy; stockpiling; price controls; tariffs and import quotas; and international development loans and trade credits. The government variable includes the U.S. Government, as well as foreign governments. For example, consider that a report by the U.S. Bureau of Mines has stated that at least 40 percent of the total mine production of copper in market economy countries was produced by firms in which various foreign governments owned an equity interest.[28] The significance of government ownership and involvement in the production of copper is that the forces of supply and demand are distorted by the involvement.

2) Environmental regulations. Since roughly 1970, environmental regulations have evolved to the point that they have become a major variable that must be considered in the corporate decision making process. Here again, government actions are important.

3) Corporate organizational strategy. This category includes the corporation's strategy with respect to variables such as remaining or becoming an integrated copper producer versus a non-integrated copper producer, or perhaps leaving the industry entirely.

Many of the companies that produce refined copper are integrated producers; that is, they own the facilities to treat copper during each of the four principal stages of processing: mining, milling, smelting, and refining. Also, several of the producers are integrated one additional step into the fabrication of refined copper. However, not all companies in the copper industry are integrated producers. There are companies that only mine and mill copper ore to produce copper concentrate, and then have the copper concentrate smelted and refined on a custom basis (the smelter takes ownership of the copper) or on a toll basis (the smelter charges a service fee and returns the copper to the owner). The existence of both integrated and non-integrated producers introduces a complex economic element into this analysis. That complex economic element manifests itself in the choice of the appropriate profit center to use in the analysis. This standard affects only one stage of the production process (smelting) in a direct way, but has indirect effects on the other stages (mining, milling, and refining).

For accounting purposes, integrated producers frequently view the smelter as a cost center, rather than a profit center. However, in an economic sense the smelter provides a distinct contribution to the production process that ultimately allows a profit to be earned, although that profit may be realized for accounting purposes at another stage of the production process such as the mine or refinery.

4) Competition. Mines have long-run flexibility in deciding where they will send their copper concentrate for smelting. Therefore, copper smelters face competition from three sources: other existing domestic smelters, new smelters that may be built, and foreign smelters, especially Japanese. Other competition, though less direct, is also

important. For example, copper scrap and substitutes such as plastic and aluminum present competition.

Japan is a major force among copper producing countries in terms of its volume of smelting, refining, and fabrication of copper. However, Japan does not have copper ore deposits of any noteworthy size. Therefore it must import concentrates in order to supply its smelting, refining, and fabricating facilities. Japan seeks concentrates from many countries, including the United States. Japan's ability to be competitive with U.S. smelters for U.S. concentrates is indicated by the contractual arrangements it has established with Anamax and Anaconda to purchase concentrates. Also, the Japanese smelters have approached many other copper mine owners in the United States. For example, Cyprus Corporation is reported to have seriously considered shipping concentrates from its Bagdad mine to Japan.

The cost to transport concentrates across the Pacific Ocean is significant. The fact that Japanese smelters can compete with U.S. smelters, in spite of the costs to transport concentrates across the Pacific Ocean, is quite noteworthy. One factor that explains the Japanese ability to compete is that Japanese smelters are newer than U.S. smelters and, in theory, should be more cost competitive. Other factors that operate to the advantage of Japanese smelters, including a protective tariff mechanism, are described later.

The existence of competition for concentrates introduces what is commonly referred to as a "trigger" price. The "trigger" price is that price which triggers or provides an economic incentive for the supplier of concentrate to change to another smelter and refinery. If a given smelter charges a service fee in excess of competing smelters, that smelter will lose business and eventually be forced to cease operations. In the case of new smelters or expansions, the new process facilities will not be built. Faced with an increase in costs, a smelter could respond using one of three options, or any combination of the three. First, the smelter could pass the costs forward in the form of a price increase. Two important considerations with respect to a price increase are: the prices of competitors in the copper business, and the elasticity of demand for the end users of copper. For example, even if all copper producers experience the same increase in costs, at some point the end users of copper will consider changing to a substitute. Second, the smelter could absorb the cost increase by reducing its profit margins, thereby reducing its return on investment (ROI). If the smelter's profit margins are reduced significantly it will cease operation. Third, the smelter could pass the costs back to the mines by reducing the price it is willing to pay for concentrate. An important consideration in setting the service fee a smelter charges for custom or toll smelting is that the concentrate may be shipped elsewhere, such as to Japan. Market conditions suggest that the option of passing costs back to the mines does not seem feasible at this time, due to the existence of excess smelting capacity.

F.2.3.1 Japanese Tariff Mechanism. One example of foreign government assistance to the copper industry occurs in Japan. Japanese copper producers operate under a system that permits the payment of a premium for concentrates, which is then recovered through a premium for refined copper, due to a protected internal market supported by a high tariff. Japan imposes high import duties on refined unwrought copper, while allowing concentrates to be shipped into the country duty-free. Duty on refined unwrought copper in 1981 was 8.2 percent of the value of the copper, including freight and insurance, as opposed to a U.S. customs duty of 1.3 percent of the value of copper. The import duties allow Japanese producers to sell their refined copper in Japan at an artificially high price and still remain competitive with foreign producers.

Specifically, copper concentrates and ore imported into Japan are free of duty. Refined copper imported into Japan is subjected to a tariff of 15,000 yen/Mg.[29] Using a December 1982, exchange rate of $0.003623/yen, the tariff was $0.0543/kg. Refined copper may be duty-free under the preferential tariff, subject to certain limitations.

As a result of the tariff situation, Japanese copper producers can pay a premium to attract concentrates and can recover the premium through a premium on the price of the refined copper used in Japan. If the refined copper is returned to the customer outside of Japan, the premium on the price of refined copper is not recovered because world prices would prevail in this case, rather than the protected internal Japanese producer price. As a result, the principal interest of the Japanese copper producers is in producing copper for internal consumption. Toll smelting in Japan is generally used as a means of balancing inventories. The absence of a tariff on ore and concentrates encourages companies to import ore into Japan. The presence of a tariff on refined copper and the costs of holding metal in Japan discourage companies from importing refined copper into Japan.

The Japanese tariff on refined copper, combined with the cost of holding the metal until users have a demand for it, provides an extra margin for Japanese copper producers. The Japanese producers can charge what the market will bear for their copper and still remain competitive with the importers. The loss incurred by Japanese producers in charging toll customers low processing rates is covered by the extra margin of profit realized by charging prices for Japanese refined copper at competitive import levels.

Robert H. Lesemann (industry expert, formerly with Metals Week, now with Commodities Research Unit), in an affidavit for the Federal Trade Commission, outlined the situation in September 1979:

> It is generally true that operating costs of U.S. smelters are the same as smelters in Japan, Korea, and Taiwan. The competitive advantage is without doubt due to the subsidies outlined above. Thus, while the terms of the Nippon-

Amax deal have not been revealed, the treatment charge is likely well below the operating cost levels of U.S. smelters.[30]

F.2.3.2 Other Japanese Advantages. The tariff mechanism described above is one example of government assistance to the Japanese copper industry. Another example is provided by the Japanese government's approval of a brass rod production cartel. In an effort to reduce stocks and boost profit margins for the ailing Japanese brass rod industry, the government officially approved the formation of a temporary cartel to cut production.[31]

Apart from government assistance, other reasons are cited for the advantage of the Japanese copper industry over the U.S. copper industry. Additional reasons include:

- A high debt-to-equity ratio--a typical Japanese smelter may have a debt-to-equity ratio of 0.8 to 0.9.[32,33,34]
- Lower labor rates--Japanese hourly rates in the primary metals industry were estimated to be about two-thirds of the U.S. rate in 1978.[35]
- By-product credits--the market for by-products, sulfuric acid, and gypsum is better in Japan than in the United States and reduces operating costs significantly.[36]

F.2.4 Maximum Percent Price Increase

Insight into the economic effects of the arsenic NESHAP can be gained by examining the maximum percentage copper price increase that would occur if all control costs were passed forward. A complete pass forward of control costs may not be possible in every case, and later in the analysis this assumption is relaxed. However, the initial assumption that a complete pass forward is possible in every case introduces a common reference point, which then facilitates comparisons of various control alternatives and scenarios.

The maximum percentage price increase is calculated using a simplified approach, for ease of presentation, that divides annualized control costs by the appropriate production and further divides that result by the refined price of copper, with the result expressed as the necessary percentage price increase per kilogram. The above approach does not consider the investment tax credit, and thus is a conservative approach that will tend to overstate the effects of the control costs. The investment tax credit would act to reduce the capital cost of the control equipment by ten percent. Other approaches could be used to determine price increases. For example, a net present value (NPV) approach could be used. A net present value approach determines the revenue increases necessary to exactly offset the control costs, such that the NPV of the plant remains constant. An NPV analysis can also take into account the investment tax credit, depreciation over the applicable time period, income taxes, operating and maintenance costs, and the time value of money. Although the NPV approach is a more sophisticated calculation, the two approaches yield similar results. Therefore, the first method is preferable in this particular case due to its straightforward nature, ease of presentation, and reasonable results.

Table F-6 shows the cost increase, and then Table F-7 shows the maximum percentage price increase, of arsenic controls for primary copper smelters. The increase in the cost of production is shown for two capacity utilization rates, 100 percent and 80 percent. The advantage of presenting two capacity utilization rates is in the conduct of sensitivity analysis. A rate of 100 percent is optimistic, but is useful here as a reference point. A rate of 80 percent is more likely and as noted in Section F.1 this is the approximate industry average utilization rate achieved in 1981. For 1982, the industry average capacity utilization rate was substantially lower at 59 percent. However, no analysis is shown here of the impact of control costs on the industry at a 59 percent utilization rate because regardless of control costs, a rate of 59 percent is damaging to the industry even as a baseline condition. Alternatives II, III, and IV are shown as well as the combination of III+IV. The smelters are ranked according to the cost of Alternative III+IV (with the exception of Kennecott-McGill). The Kennecott-McGill smelter is shown last because it is the only smelter faced with costs under Alternative II. The purpose of showing the increase in production cost is to supplement the maximum percentage price increase that is discussed later. One advantage of reviewing the cost increase is that it is only dependent on the capacity utilization rate, and is not affected by the refined price of copper. A second advantage is that it is not affected by the choice of the profit center. Several points should be observed from the cost increases:

1) The amount of the cost increases are substantial for two of the smelters in particular, Cities Service-Copperhill, and Kennecott-McGill. The cost increases are substantial for several reasons. First, copper is a commodity, which means that product differentiation is not possible and thus competition is based almost exclusively on price. The copper producers can be characterized as price-takers and thus no individual producer controls the marketplace. Therefore, in an industry that competes based on price, the cost of production becomes exceptionally important. Second, copper is traded on an international basis and thus domestic producers compete among themselves, as well as against foreign producers that may not experience the same cost increases. Finally, copper is faced with a significant threat from substitutes: such as, aluminum and plastic.

2) Within a single alternative, the differences among smelters are substantial. As described above, copper producers compete principally on price. As a result, the cost of production is quite important. Therefore differences in costs among smelters of as little as several cents per kilogram of copper are important.

Table F-6. INCREASE IN COST OF PRODUCING COPPER DUE TO ARSENIC CONTROLS FOR PRIMARY COPPER SMELTERS (¢/kg.)[a]

Smelter	Annual Capacity (Mg.)	100% Capacity Alternative				80% Capacity Alternative			
		II	III	IV	III+IV	II	III	IV	III+IV
ASARCO-Hayden	182,000	0	0.4	0	0.4	0	0.5	0	0.5
ASARCO-El Paso	91,000	0	0.4	0	0.4	0	0.5	0	0.5
Phelps Dodge-Hidalgo	163,000	0	1.1	0.2	1.3	0	1.3	0.2	1.5
Kennecott-Garfield	254,000	0	0.9	0.9	1.8	0	1.1	1.1	2.2
Phelps Dodge-Morenci	191,000	0	1.8	0.3	2.1	0	2.2	0.3	2.5
Inspiration	136,000	0	2.1	0.2	2.3	0	2.6	0.2	2.8
Magma	181,000	0	2.2	0.3	2.5	0	2.7	0.4	3.1
Phelps Dodge-Ajo	64,000	0	2.4	0.4	2.8	0	3.1	0.5	3.6
Phelps Dodge-Douglas	115,000	0	2.5	0.4	2.9	0	3.1	0.6	3.7
Copper Range-White Pine	52,000	0	2.5	0.5	3.0	0	3.1	0.6	3.7
Kennecott-Hayden	71,000	0	3.0	0.4	3.4	0	3.8	0.5	4.3
Kennecott-Hurley	73,000	0	3.7	0.4	4.1	0	4.6	0.5	5.1
Cities Service-Copperhill	13,600	0	9.4	1.9	11.3	0	11.7	2.4	14.1
Kennecott-McGill	45,000	22.7	4.9	0.6	5.5	28.4	6.1	0.7	6.8

[a] To convert from kilograms to pounds divide by 2.2.

Table F-7. MAXIMUM PERCENT PRICE INCREASE FOR ARSENIC CONTROLS FOR PRIMARY COPPER SMELTERS (%)

Smelter	187¢/kg.Price								220¢/kg.Price							
	100% Capacity Alternative				80% Capacity Alternative				100% Capacity Alternative				80% Capacity Alternative			
	II	III	IV	III+IV	II	III	IV	III+IV	II	III	IV	III+IV	II	III	IV	III+IV
ASARCO-Hayden	0	0.2	0	0.2	0	0.3	0	0.3	0	0.2	0	0.2	0	0.2	0	0.2
ASARCO-El Paso	0	0.2	0	0.2	0	0.3	0	0.3	0	0.2	0	0.2	0	0.2	0	0.2
Phelps Dodge-Hidalgo	0	0.6	0.1	0.7	0	0.7	0.1	0.8	0	0.5	0.1	0.6	0	0.6	0.1	0.7
Kennecott-Garfield	0	0.5	0.5	1.0	0	0.6	0.6	1.2	0	0.4	0.4	0.8	0	0.5	0.5	1.0
Phelps Dodge-Morenci	0	1.0	0.2	1.2	0	1.2	0.2	1.4	0	0.8	0.1	0.9	0	1.0	0.1	1.1
Inspiration	0	1.1	0.1	1.2	0	1.4	0.1	1.5	0	1.0	0.1	1.1	0	1.2	0.2	1.3
Magma	0	1.2	0.2	1.4	0	1.4	0.2	1.6	0	1.0	0.1	1.1	0	1.2	0.2	1.4
Phelps Dodge-Ajo	0	1.3	0.2	1.5	0	1.7	0.3	2.0	0	1.1	0.2	1.3	0	1.4	0.2	1.6
Phelps Dodge-Douglas	0	1.3	0.2	1.5	0	1.7	0.3	2.0	0	1.1	0.2	1.3	0	1.4	0.3	1.7
Copper Range-White Pine	0	1.3	0.3	1.6	0	1.7	0.3	2.0	0	1.1	0.2	1.3	0	1.4	0.3	1.7
Kennecott-Hayden	0	1.6	0.2	1.8	0	2.0	0.3	2.3	0	1.4	0.2	1.6	0	1.7	0.2	1.9
Kennecott-Hurley	0	2.0	0.2	2.2	0	2.5	0.3	2.8	0	1.7	0.2	1.9	0	2.1	0.2	2.3
Cities Service-Copperhill	0	5.0	1.0	6.0	0	6.3	1.3	7.6	0	4.3	0.9	5.2	0	5.3	1.1	6.4
Kennecott-McGill	12.1	2.6	0.3	2.9	15.2	3.3	0.4	3.7	10.3	2.2	0.3	2.5	12.9	2.8	0.3	3.1

3) The cost increases for Alternative II are 0 in every case with one exception, Kennecott-McGill. For Kennecott-McGill the costs for Alternative II are large. The cost increases for Alternative III range from a low of 0.4¢/kg to a high of 9.4¢/kg. The costs for Alternative IV are lower, and range from 0 to 1.9¢/kg. The costs for Alternative III+IV range from 0.4¢/kg to 11.3¢/kg.

Table F-7 shows maximum percentage price increases. The purpose of reporting the maximum percentage price increase figures is to add perspective to the cost increase figures. Results are shown for two refined copper prices (187 cents per kg. and 220 cents per kg.), and for the same two capacity utilization rates presented earlier, 100 percent and 80 percent. The same cases are shown as were presented earlier for the cost increases, Alternatives II, III, IV, and III+IV. The price increase assumes the firm is an integrated producer. The average annual price for refined copper over the past five years, from 1978 to 1982, has been approximately 187 cents per kg. The price of copper is difficult to predict, and therefore a second price is examined. As shown previously in Section F.1, the highest average annual current dollar price for refined copper was 225.3 cents per kilogram, achieved in 1980. (The year 1980 was marked by an industry strike and reduced production.) Therefore, 220¢/kg is used to represent a price that, based on the results of past years, appears optimistic. This "optimistic" price of 220¢/kg is useful as a reference point for sensitivity analysis and also as an approximate upper limit to the range of probable serious economic effects. At a price greater than 220¢/kg the financial health of the industry would be improved dramatically and consequently the effects of the control costs would be reduced sharply. An alternative "pessimistic" price is not presented because even the baseline results are highly likely to be damaging using a pessimistic price, and thus the addition of control costs would merely reinforce an obvious conclusion. A ready example of the effects of a price significantly below 187¢/kg was provided in 1982 when the average price for the year was about 163¢/kg and large segments of the industry closed for sustained periods.

The analysis of the results for the maximum percentage price increase figures is similar to the analysis discussed above for the cost increase figures. Once again, for Alternative II only Kennecott-McGill experiences a price increase. The price increase is high, 12.1 percent based on a 100 percent capacity utilization rate and a price of 187¢/kg. For Alternative III the maximum price increases range from 0.2 to 5.0 percent. For Alternative IV the price increases are lower, and range from 0 to 1.0 percent. For Alternative III+IV the price increases range from 0.2 to 6.0 percent, with two smelters above 2.2 percent. The two smelters are Cities Service-Copperhill at 6.0 percent and Kennecott-McGill at 2.9 percent. There is some variation in the price increases among the smelters. The significance of the variation in the maximum percentage price increases among the smelters is that those smelters with higher price increases would probably be constrained in the marketplace by those smelters with lower price increases. As a result, at least some of the smelters could quite possibly have to absorb a part of the control costs. As mentioned above, two additional constraining influences are foreign competition and substitutes.

F.2.5 Maximum Percent Profit Reduction

Apart from the calculation of maximum percentage price increase, additional insight into the economic effects of the arsenic NESHAP can be gained by making the opposite assumption from maximum percent price increase, that is, zero percent price increase, or complete control cost absorption. The assumption of complete control cost absorption provides a measure of the reduction in profits if the control costs are absorbed completely.

Assuming control costs are absorbed, the critical element in an analysis of profit reduction is the profit margin. The larger a firm's profit margin, the greater is the firm's ability to absorb control costs and earn an acceptable rate of return on investment (ROI), and thus continue operation. The profit margin is simply the difference between price and production cost. As mentioned in an earlier section, the central issue becomes the choice of an appropriate profit center and its corresponding price and cost. The processing of virgin ore into refined copper involves four distinct steps: mining, milling, smelting, and refining. Although the four steps are often joined to form an integrated business unit, they are not inextricably bound together in an economic sense. For example, it is not uncommon for mines to have their concentrate toll smelted and refined. The difficulty that this variability presents in terms of an assessment of the effects of the arsenic standard is in the method of assigning the costs.

This report presents an analysis of profit impacts using two methods. The first method assumes copper producers are fully integrated and all have the same costs and thus earn a uniform profit margin. The objective of this method is to permit a ready, and uniform, examination of profit impacts. With the first method as a foundation, the second method introduces more smelter specific variables into the analysis in an effort to focus more sharply on the complex organizational structure of the industry.

F.2.5.1 Method One. As mentioned above, the critical element in an examination of profit reduction is the profit margin. Therefore an examination of profit margins for members of the industry is presented below. Table F-8 shows the revenues and operating profit (before tax) for each of the seven copper producers that own smelters, for the period from 1977 to 1982. Table F-8 also shows the percentage profit margin, which is operating profit divided by revenues. The revenue and operating profit figures are for the business segment within the company that includes copper. The use of business segment information provides a closer representation of the results for copper than would the use of the consolidated results for the company. The reason for this is that for several of the firms copper represents a relatively small share of the total company results. Although the business

Table F-8. BUSINESS SEGMENT RETURN ON SALES FOR COPPER COMPANIES[a]

($ 10^3)

	Year	ASARCO	Cities Service	Copper Range[b]	Inspiration[c]	Kennecott	Magma[d]	Phelps Dodge
Revenues	1977	733,293	184,000	NA	95,676	NA	NA	453,184
	1978	849,002	241,500	64,600	101,251	683,000	274,137	446,970
	1979	1,339,917	276,300	89,300	136,849	1,091,400	381,512	618,188
	1980	1,440,220	224,100	83,900	178,004	987,400	287,581	714,591
	1981	1,153,022	NA	72,300	NA	539,000	328,842	706,404
	1982	1,074,014	NA	36,400	NA	596,000	221,001	426,509
Operating Profit[e]	1977	65,919	(38,600)	NA	(9,994)	NA	NA	52,831
	1978	112,474	(23,900)	(6,600)	(6,235)	(100)	13,601	63,738
	1979	225,763	25,400	10,000	9,889	164,000	67,252	159,428
	1980	145,286	16,300	1,800	(6,563)	131,400	11,522	95,439
	1981	68,364	NA	(20,600)	NA	(99,000)	(15,658)	27,618
	1982	35,783	NA	(42,000)	NA	(187,000)	(30,790)	(78,104)
Profit/ Revenues (percent)	1977	9.0	(21.0)	NA	(10.4)	NA	NA	11.7
	1978	13.2	(9.9)	(10.2)	(6.2)	0	5.0	14.3
	1979	16.8	9.2	11.2	7.2	15.0	17.6	25.8
	1980	10.1	7.3	2.1	(3.7)	13.3	4.0	13.4
	1981	5.9	NA	(28.5)	NA	(18.4)	(4.8)	3.9
	1982	3.3	NA	(115.4)	NA	(31.4)	(13.9)	(18.3)
Average		9.7	(3.6)	(28.2)	(3.3)	(4.3)	1.6[f]	8.5[g]

[a] Business segments contain other products in addition to copper.

[b] The figures are for The Louisiana Land and Exploration Company which acquired Copper Range in May 1977.

[c] Acquired and privately-owned after 1980 by Anglo American Corp. of South Africa through a complex arrangement that includes Minerals & Resources Corp. (Minorco), Hudson Bay Mining & Smelting Co., and Plateau Holdings Inc.

[d] Profit is net income after tax in this case.

[e] Before interest and tax.

[f] Would yield 2.3 percent if adjusted to before tax with an effective tax rate of 30 percent.

[g] Imputed profit on intersegment sales for 1977 to 1982 would yield average return of about 9.8 percent.

segment information is a better representation of the results for copper than the total company results, the business segments contain other products in addition to copper. Therefore conclusions must be drawn accordingly. The table shows that there is considerable variation in results, both within a company from one year to the next, as well as from one company to the next. The averages range from a loss of 28.2 percent to a high of 9.7 percent. Rather than a profit, four of the seven companies show an average loss.

Table F-9 shows the maximum percentage reduction in the profit margin for each of the 14 smelters. This table assumes each smelter is viewed as part of a fully integrated operation. Two profit levels are shown and two capacity utilization rates (100 percent and 80 percent). The first profit level is based on a refined copper price of 187¢/kg and a 10 percent profit margin, which yields a profit of 18.7¢/kg. The second profit level is based on an increased price of refined copper to a level of 220¢/kg. The second profit margin is based on the original 18.7¢/kg. but adds the increase in price as extra profit while process costs are held constant. The second profit margin is 51.7¢/kg. Three considerations suggest the use of the second profit margin. The first consideration is the desirability of presenting sensitivity analysis in general. The second consideration is that a profit margin of 51.7¢/kg. based on a price of 220¢/kg. is a margin of 23.5 percent, which though clearly high, has been achieved within recent years by a member of the industry. Finally, because the margin is high, it in effect can be viewed as an upper limit, and thus any smelter that has a substantial profit reduction in spite of such a favorable profit margin is in a very vulnerable position at a lower, more likely, profit margin.

The same cases discussed earlier are still applicable, the results on Table F-9 are for Alternatives II, III, IV, and III+IV. At the first profit margin (18.7¢/kg.), with a 100 percent capacity utilization rate for Alternative III + IV, eight smelters have a maximum profit reduction of 15 percent or less, and three smelters have a reduction of 15 to 20 percent. The results show a maximum profit reduction of greater than 20 percent for three of the 14 smelters (Kennecott-Hurley, Cities Service-Copperhill, and Kennecott-McGill) at the 100 percent capacity utilization rate for Alternative III+IV. At the more likely level of an 80 percent capacity utilization rate, six smelters have a reduction of 15 percent or less, four smelters have a reduction of between 15 and 20 percent, and four smelters exceed 20 percent (Kennecott-Hayden, Kennecott-Hurley, Cities Service-Copperhill, and Kennecott-McGill). A profit reduction in excess of 20 percent is a substantial reduction, but when viewed in isolation is not a definite indicator of closure. However, a profit reduction in excess of 20 percent, when viewed together with the generally depressed economic condition of the copper industry, is a cause for concern about the ability of the four smelters in this category to continue in operation. Also, Table F-9 shows that of the four smelters between 15 and 20 percent, three smelters have profit reductions in excess of 19 percent, Table F-9. MAXIMUM PERCENT PROFIT DECREASE FOR ARSENIC CONTROLS FOR PRIMARY COPPER SMELTERS (%)

Smelter	18.7¢/kg.Profit Margin[a]								51.7¢/kg.Profit Margin[b]							
	100% Capacity Alternative				80% Capacity Alternative				100% Capacity Alternative				80% Capacity Alternative			
	II	III	IV	III+IV	II	III	IV	III+IV	II	III	IV	III+IV	II	III	IV	III+IV
ASARCO-Hayden	0	2.1	0	2.1	0	2.7	0	2.7	0	0.8	0	0.8	0	1.0	0	1.0
ASARCO-El Paso	0	2.1	0	2.1	0	2.7	0	2.7	0	0.8	0	0.8	0	1.0	0	1.0
Phelps Dodge-Hidalgo	0	5.9	1.1	7.0	0	7.0	1.1	8.0	0	2.1	0.4	2.5	0	2.5	0.4	2.9
Kennecott-Garfield	0	4.8	4.8	9.6	0	5.9	5.9	11.8	0	1.7	1.7	3.4	0	2.1	2.1	4.2
Phelps Dodge-Morenci	0	9.6	1.6	11.2	0	11.8	1.6	13.4	0	3.5	0.6	4.1	0	4.3	0.6	4.9
Inspiration	0	11.2	1.1	12.3	0	13.9	1.1	15.0	0	4.1	0.4	4.5	0	5.0	0.4	5.4
Magma	0	11.8	1.6	13.4	0	14.4	2.1	16.6	0	4.3	0.6	4.9	0	5.2	0.8	6.0
Phelps Dodge-Ajo	0	12.8	2.1	14.9	0	16.6	2.7	19.3	0	4.6	0.8	5.4	0	6.0	1.0	7.0
Phelps Dodge-Douglas	0	13.4	2.1	15.5	0	16.6	3.2	19.8	0	4.8	0.8	5.6	0	6.0	1.2	7.2
Copper Range-White Pine	0	13.4	2.7	16.1	0	16.6	3.2	19.8	0	4.8	1.0	5.8	0	6.0	1.2	7.2
Kennecott-Hayden	0	16.0	2.1	18.1	0	20.3	2.7	23.0	0	5.8	0.8	6.6	0	7.4	1.0	8.4
Kennecott-Hurley	0	19.8	2.1	21.9	0	24.6	2.7	27.3	0	7.2	0.8	8.0	0	8.9	1.0	9.9
Cities Service-Copperhill	0	50.3	10.2	60.4	0	62.6	12.8	75.4	0	18.2	3.7	21.9	0	22.6	4.6	27.2
Kennecott-McGill	121.4[c]	26.2	3.2	29.4	151.9[c]	32.6	3.7	36.3	43.9	9.5	1.2	10.7	54.9	11.8	1.4	13.2

[a] Based on a refined copper price of 187¢/kg and a 10 percent profit margin.

[b] Based on a refined copper price of 220¢/kg and a 23.5 percent profit margin.

[c] A 100 percent decrease in profit is a complete elimination of profit. A decrease of more than 100 percent means that costs increase by more than total profit, i.e., a loss occurs.

which though less than 20 percent, is not appreciably different from 20 percent. For two of the above smelters (Cities Service-Copperhill and Kennecott-McGill) the profit reduction is greater than 30 percent at the 80 percent capacity utilization rate, and greater than 50 percent for one smelter (Cities Service-Copperhill). Profit reductions of greater than 30 percent would seriously call into question the continued viability of these two smelters.

At the second, higher, profit margin (51.7¢/kg.) the profit reductions are lessened substantially. Only two smelters have profit reductions of greater than 10 percent. However, the Cities Service-Copperhill smelter continues to experience profit reductions of greater than 20 percent.

F.2.5.2 Method Two. Method two uses method one as a starting point and then supplements it with additional information, some of which is qualitative. Table F-10 provides an added means to identify those smelters that are most likely to face the greatest impact. Method one assumed that each smelter was part of a fully integrated operation. However, not all smelters are integrated to the same degree, and therefore additional variables are introduced in method two in order to examine the degree of integration for each smelter. The significance of whether a smelter is analyzed as part of an integrated business unit or analyzed on a "stand alone" basis is that the financial effect of the control costs is greater for a smelter that must "stand alone", versus a smelter that is part of an integrated operation. Additionally, a smelter plus a refinery could be considered together as a single business unit, depending on the individual circumstances. For example, the production costs associated solely with smelting (excluding mining, milling, and refining) will vary depending on the individual smelter but a representative figure is approximately 42¢/kg. This represents about 25 percent of total production costs from mining through refining. Therefore if the total integrated profit presented earlier of 18.7¢/kg is apportioned to each stage of production in proportion to the costs associated with each stage of production the result is that only about 25 percent of the total profit of 18.7¢/kg is assigned to the smelter. The net effect is that if the control costs are charged against only the smelter's share of the total profit the control costs increase in importance.

Table F-10 starts by showing the smelters ranked according to the profit reduction described earlier for Alternative III+IV at the 80 percent capacity utilization rate . The size of the profit reduction and the rank provides one indication of the potential effect of controls. A caveat that should be mentioned concerning this indicator is that it does not take into consideration baseline costs. The profit reductions expressed on the basis of a fully integrated operation were discussed previously in method one and will not be repeated here. However, for perspective, if the smelters are viewed on a stand alone basis, rather than as part of a fully integrated operation, the size of the profit reductions could at least double.

Table F-10. REVIEW OF PRIMARY COPPER SMELTERS

Smelter	Profit Reduction		Major Recent Capital Commitment	Major Integrated Mine	Closely Associated Refinery	Viability Estimates By Others (Reference #)	Summary of Recent Operating Status
	rank -	(%)					
ASARCO-Hayden	1	2.7	1982	No	No	Viable-37	Modernization
ASARCO-El Paso	2	2.7	1978	No	No	Viable-37	Open continually
Kennecott-Garfield	3	8.0	1978	Yes	Yes	Viable-37	Open continually
Phelps Dodge-Hidalgo	4	11.8	1976	Yes	No	Viable-37	Open continually
Phelps Dodge-Morenci	5	13.4	1982	Yes	No	Viable-37	Closed 4/82-10/82
Inspiration	6	15.0	1980	Yes	Yes	Doubtful-38,37	Open continually
Magma	7	16.6	1974	Yes	Yes	Viable-37	Open continually
Phelps Dodge-Ajo	8	19.3	No	Yes	No	Doubtful-38,37,39	Closed 4/82-present[a]
Phelps Dodge-Douglas	9	19.8	No	No	No	Doubtful-38,16 Closure-37,39	Closed 4/82-7/82 11/82-4/83
Copper Range-White Pine	10	19.8	NA[b]	Yes	Yes	Viable-37	Closed 10/82-present[a]
Kennecott-Hayden	11	23.0	NA	Yes	No	Viable-37	Closed 5/82-present[a]
Kennecott-Hurley	12	27.3	1982	Yes	Yes	Doubtful-37	Modernization
Cities Service-Copperhill	13	75.4	NA	Yes	No	Viable-37	
Kennecott-McGill	14	36.3	No	No	No	Doubtful-38,37,16	Closed 6/82-present[a]

[a] as of 4/84.
[b] NA = not available

A second indicator that is presented to provide additional insight into a firm's possible reaction to control costs is a review of any major capital commitments to the smelter that a firm has made recently. Most of the firms with the lower control cost increases have also recently made major capital commitments to their smelters which in turn suggests a stronger commitment to the continued operation of a smelter than a firm that has postponed capital expenditures for a smelter.

A third indicator is provided by a review of whether or not a smelter has a major integrated mine that supplies much or all of its concentrates. The presence of a major mine near a smelter does not guarantee that a firm will consider the mine and smelter as a single business unit. For example, both the Phelps Dodge-Ajo smelter and the Kennecott-Hayden smelter have been closed in spite of the fact that the mines located near these two smelters have been open. However, in general a smelter that is associated with a major mine is likely to be considered as an integrated operation.

A fourth indicator is provided by a review of whether or not a smelter is closely associated with a refinery. Similar to the situation with a mine, the existence of a refinery closely associated with a smelter does not guarantee that a firm will consider the smelter and refinery as a single business unit. However, in general this is likely to be the case because if a closure occurs at a smelter that provides all, or a substantial percentage, of the copper supply for a refinery this will have serious consequences for the refinery.

A fifth indicator is provided by the estimates of others who have analyzed the smelters. The estimates are from four sources as noted in the references. The estimates are based on the overall economic and environmental outlook faced by the smelters, and are not estimates related specifically to arsenic control costs.

A sixth and final indicator is provided by a review of the recent operating status of the smelters. Those smelters that have recently been closed for sustained periods of time are obviously in a vulnerable financial condition even in the absence of arsenic control costs. Therefore the weak baseline financial condition of those smelters reduces the affordability of arsenic control costs. Two smelters are involved in major modernization programs, ASARCO-Hayden and Kennecott-Hurley.

F.2.6 Capital Availability

The principal determinant of the financial viability of a smelter is profitability. However, the amount of capital needed to purchase control equipment is one of the components that enters into an evaluation of profitability. Most firms prefer to finance pollution control equipment with debt, both because debt is less expensive than equity in general, and additionally because debt incurred to purchase pollution control equipment is often tax exempt. Assuming control equipment is financed with debt, as the capital cost of the control equipment increases, the level of debt increases. An increased debt level means the fixed costs required to service the debt increase and therefore the level of risk increases. As a result, a discussion of capital availability will serve to supplement an assessment of profitability.

Table F-11 shows the pollution control capital expenditures that will be necessary for each firm and for each smelter. The component parts of the capital expenditures were explained in detail in an earlier section and will not be repeated here. The baseline capital expenditures are presented, as well as the capital expenditures for Alternatives II, III, IV, and III+IV. Three firms own more than one smelter and in those three cases the total capital costs are shown, although the firms can make capital budgeting decisions on an individual smelter basis. The capital costs for the smelters are not trivial sums. However, all seven companies are major corporations with a large capital base. Additionally, five of the seven companies are owned wholly, or to a substantial degree, by significantly larger parent corporations and thus are quite likely to have access to the necessary capital. The remaining two companies that are not owned by some other corporation are ASARCO and Phelps Dodge.

For these two companies Table F-11 shows the percent increase in long-term debt if controls are added. For the other companies the increases are below one percent and are not shown. The pre-control debt level is based on a 3-year average (1981 to 1979) debt level for each company. Controls are assumed to be financed totally with debt. The baseline percentage increase in debt is 24 percent for ASARCO and 16 percent for Phelps Dodge. These increases are considerable. For Alternatives II, III, IV, and III+IV the incremental increases are generally moderate. In ASARCO's case the increases are 0, 2, 1, and 3 percent respectively. In the case of Phelps Dodge the increases are 0, 6, 1, and 7 percent, respectively. The capital costs associated solely with Alternatives II, III, IV, and III+IV do not, in isolation, suggest a major capital availability problem. However, the baseline increase, taken together with the alternatives, is a considerable increase and may be a problem for these two companies.

An additional indicator of capital availability is provided by the debt rating assigned to a company by one of the major national rating services. Although the rating is assigned specifically for a company's debt, the factors that enter into a debt rating include the overall financial condition of a company. Therefore a debt rating is also an indirect measure of the overall financial condition of a company. In 1982, as well as 1981 and 1980, ASARCO's debt was rated as A3 by Moody's.[40] This is an investment grade rating, but it is the lowest A rating. In 1982, the debt rating by Moody's for Phelps Dodge was lowered to Baa2 from its previous rating in 1980 and 1981 of A. Although Baa2 is still a relatively strong rating, the fact that it was lowered from 1981 to 1982 is a negative factor and suggests that substantial increases in the amount of debt held by the company may present some difficulties.

Table F-11. CAPITAL COSTS OF ARSENIC CONTROLS FOR PRIMARY COPPER SMELTERS ($$10^3$)

Company	Smelter	Baseline	Alternative			
			II	III	IV	III+IV
ASARCO	El Paso	46	0	1,894	370	2,264
	Hayden	75,606	0	3,660	0	3,660
		75,652	0	5,554	370	5,924
	Debt Increase[a,b]	24%	0%	2%	1%	3%
Cities Service	Copperhill	0	0	4,434	893	5,327
Copper Range	White Pine	0	0	4,434	893	5,327
Inspiration	Miami	0	0	9,825	922	10,747
Kennecott	Garfield	0	0	8,800	7,828	16,628
	Hayden	0	0	8,000	894	8,894
	Hurley	54,044	0	8,760	952	9,712
	McGill	0	10,530	9,000	893	9,893
		54,044	10,530	34,560	10,567	45,127
Newmont	Magma	0	0	13,050	1,786	14,836
Phelps Dodge	Ajo	0	0	6,731	894	7,625
	Douglas	0	0	9,825	1,787	11,612
	Hidalgo	0	0	6,731	894	7,625
	Morenci	95,294	0	12,971	1,786	14,747
		95,294	0	36,258	5,361	41,619
	Debt Increase[a]	16%	0%	6%	1%	7%

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[a] Percent increase in average long-term debt level for the 3 years (1981 to 1979) if controls are added as debt.

[b] Increases of less than one percent for a firm are not shown.

F.3 SOCIO-ECONOMIC IMPACT ASSESSMENT

F.3.1 Executive Order 12291

The purpose of Section F.3.1 is to address those tests of macroeconomic impact as presented in Executive Order 12291, and, more generally, to assess any other significant macroeconomic impacts that may result from the NESHAP. Executive Order 12291 stipulates as "major rules" those that are projected to have any of the following impacts:

- An annual effect on the economy of $100 million or more.
- A major increase in costs or prices for consumers; individual industries; Federal, State, or local government agencies; or geographic regions.
- Significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S.-based enterprises to compete with foreign-based enterprises in domestic or export markets.

F.3.1.1 Annualized Control Costs. The annualized control costs for each of the four alternatives is well below the $100 million which is the figure used to identify a major rule. The annualized control costs for Alternatives II, III, IV, and III+IV are $4.1 million, $29.1 million, $6.0 million, and $35.1 million, respectively.

F.3.1.2 Regional Effects, Employment and Competition. Most of the 14 primary copper smelters are located in the Southwestern United States, and in particular, seven smelters are located in Arizona. As a result, economic impacts would be concentrated in that geographical area.

A copper smelter typically employs about 500 people. A smelter has an indirect as well as a direct effect on employment in its local community. The indirect effect is twofold; one part of it results from the local business purchases that a smelter makes, and the other part results from the local consumer purchases by smelter employees and their families. These expenditures generate additional employment at local firms. An estimate of the employment multiplier for the smelting industry is approximately 1.6.

The domestic copper producers compete among themselves, as well as against foreign copper producers and substitutes such as aluminum and plastics. Any substantial increase in costs will put pressure on the competitive position of some domestic smelters with respect to other domestic smelters, and also with respect to foreign copper producers, and substitutes.

F.3.2 Regulatory Flexibility

The Regulatory Flexibility Act of 1980 (RFA) requires that differential impacts of Federal regulations upon small business be identified ential impacts of Federal regulations upon small business be identified and analyzed. The RFA stipulates that an analysis is required if a substantial number of small businesses will experience significant impacts. Both measures must be met, substantial numbers of small businesses and significant impacts, to require an analysis. If either measure is not met then no analysis is required. The EPA definition of a substantial number of small businesses in an industry is 20 percent. The EPA definition of significant impact involves three tests, as follows: one, prices for small entities rise 5 percent or more, assuming costs are passed forward to consumers; or two, annualized investment costs for pollution control are greater than 20 percent of total capital spending; or three, costs as a percent of sales for small entities are 10 percent greater than costs as a percent of sales for large entities.

The Small Business Administration (SBA) definition of a small business for Standard Industrial Classification (SIC) Code 3331, Primary smelting and refining of copper is 1,000 employees. Table F-12 shows recent employment levels for each of the seven companies that own primary copper smelters. All seven have more than 1,000 employees. Therefore, none of the seven companies meets the SBA definition of a small business and thus no regulatory flexibility analysis is required.

Table F-12. NUMBER OF EMPLOYEES AT COMPANIES THAT OWN PRIMARY COPPER SMELTERS

Company	Employees	Source[a]
ASARCO, Inc.	9,800	1982 SEC 10-K p. A3
Cities Service Co.	18,900	1980 SEC 10-K p. 6
Copper Range Co.[b]	3,049	1980 SEC 10-K p. 22
Inspiration Consolidated Copper Co.	2,180	1980 SEC 10-K p. 2
Kennecott Corp.[c]	35,000	1980 SEC 10-K p. 10
Newmont Mining Corp.	9,900	1982 SEC 10-K p. 5
Phelps Dodge Corp.	9,678	1982 SEC 10-K p. 1

[a] SEC 10-K is Securities and Exchange Commission, Form 10-K.

[b] Copper Range Co. is a wholly-owned subsidiary of the Louisiana Land and Exploration Company. Figures are for Louisiana Land and Exploration.

[c] Prior to merger with Sohio on March 12, 1981.

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APPENDIX G

DEVELOPMENT OF MAIN STACK AND LOW-LEVEL ARSENIC EMISSION RATES FOR THE ARSENIC PLANT AT ASARCO-TACOMA

DEVELOPMENT OF MAIN STACK AND LOW-LEVEL ARSENIC EMISSION RATES FOR THE ARSENIC PLANT AT ASARCO-TACOMA

G.1 INTRODUCTION

Estimates of inorganic arsenic emissions from the ASARCO-Tacoma smelter were presented in the high-arsenic proposal BID, EPA-450/3-83-009a (III-B-1). Since the standard was proposed, EPA has revised these emission estimates after making several visits to the smelter, and through an extensive test program. On June 21 through 23, 1983, EPA conducted a comprehensive inspection of the smelter to identify potential sources of low-level emissions and to document the particular control measures and practices already being applied at the smelter. On September 12 through 29, 1983, EPA conducted source testing on the No. 1 Cottrell and the arsenic plant main fabric filter (referred to as the "arsenic plant baghouse"). Results from these tests are presented in Appendix H.

Arsenic emission rates at ASARCO-Tacoma were estimated for two categories of sources: (1) main stack emissions, consisting of outlet gas streams from six control devices used at the smelter that are vented to the smelter's 563-ft main stack; and (2) low-level emissions, or those from all other arsenic emission points at the smelter. Main stack emission rates were derived generally from an arsenic material balance for the smelter based on actual smelter operations during 1982. In the case of the arsenic plant, contributions to main stack emissions were determined from the September 1983, test results referred to above.

Low-level arsenic emissions were estimated for two groups of emission controls. The first group of controls consists of those in place at the ASARCO-Tacoma smelter as of December 31, 1982. The second group includes the additional emission controls that have been applied since that time or are planned under ASARCO-initiated projects, ASARCO actions to comply with the Tripartite Agreement (IV-D-447), and ASARCO actions to comply with the final arsenic NESHAP standard.

In light of ASARCO's recent closure of its copper smelting operations at Tacoma, and its continuation of the operation of the arsenic plant (arsenic trioxide and metallic arsenic production facilities) on the same site, EPA is presenting only its estimates for arsenic emissions from the arsenic plant. Therefore, the following sections discuss main stack and low-level arsenic emissions only from the arsenic plant.

G.2 ARSENIC PLANT EMISSION RATES

G.2.1 Main Stack Emissions

The process offgases from the arsenic trioxide and metallic arsenic production operations are vented to a baghouse before being ducted to the main stack. It is not known presently whether the main stack at the Tacoma smelter will be retained, but the contribution of arsenic emissions from the arsenic plant will still be vented from this baghouse, even if the main stack is removed from the site.

In September 1983, EPA conducted source tests to determine arsenic emissions at the inlet and outlet of the baghouse controlling emissions from the arsenic plant. Test results are summarized in Appendix H. The results for Run Nos. 1 through 4 show that the average arsenic emission level from this baghouse was 0.33 pound per hour (0.15 kg/h). Test results for Run Nos. 5 through 7 were not utilized in establishing average emissions because of uncertainties about the flow conditions during these test runs. After the copper smelting operation has been shut down, emissions from the arsenic plant baghouse are likely to change, but neither the magnitude nor direction of any future change can be predicted at the present time.

G.2.2 Low-Level Emissions

The low-level emission factors for the arsenic plant are based on a detailed arsenic material balance that ASARCO prepared specifically for the arsenic trioxide and metallic arsenic production facilities at ASARCO-Tacoma (II-D-42). These low-level arsenic emissions are considered to consist of contributions from seven separate operations performed in connection with running the arsenic plant. Low-level emission rates based on controls in place on December 31, 1982, and on additional controls since that date, are presented in Table G-1. The methodology used to derive these emission estimates is described in the paragraphs below. It should be recognized that these estimates reflect the present configuration at the Tacoma smelter (both copper smelter and arsenic plant in operation), and might be changed after the copper smelting operation is shut down.

G.2.2.1 Raw Material Handling. The arsenic plant material balance shows that a total of 2,682 lb/h of arsenic is handled during the various flue dust, white dust, Cottrell dust, and roaster baghouse dust transfer operations performed in the arsenic plant. The assumption is that uncontrolled arsenic emissions from the handling of these materials are 0.1 percent of the arsenic contained in the materials. The transfer operations are performed inside the arsenic plant building using a combination of covered belt conveyors, pneumatic conveyor systems, and enclosed chutes. An overall control efficiency of 90 percent is assumed for these controls. Multiplying 2,682 lb/h by 0.1 percent, an uncontrolled emission rate of 2.68 lb/h was calculated. Applying the control efficiency value of 90 percent, a low-level arsenic emission rate of 0.27 lb/h was calculated for arsenic plant raw material handling.

G.2.2.2 Godfrey Roasters. In 1983, a construction program was completed at the ASARCO-Tacoma smelter to replace the arch on the No. 5 Godfrey roaster with a poured solid-refractory arch. Solid-refractory arches previously had been installed on the No. 4 and No. 6 Godfrey roasters. (The No. 1, No. 2, and No. 3 Godfrey roasters have been removed from the arsenic plant.) Also included in the ASARCO construction program was the installation of a water-cooled screw conveyor on each Godfrey roaster for transfer of the hot calcines from the roaster. To represent baseline Godfrey roaster operations for the estimation of arsenic emissions, it is assumed that the solid-refractory arch was not in place on the No. 5 Godfrey roaster.

Table G-1. LOW-LEVEL ARSENIC EMISSION RATES FOR THE ARSENIC PLANT AT ASARCO-TACOMA

Low-Level Emission Source		Average Arsenic Emission Rate (lb/h)
Controls as of December 31, 1982		
1. Raw material handling		0.27
2. Godfrey roasters		2.18
3. Calcine handling		0.50
4. Kitchen pulling		0.76
5. Arsenic trioxide handling		0.15
6. Metallic arsenic production		0.10
7. Baghouse dust transfer		0.08
	Total	4.04
With Additional Controls		
1. Raw material handling		0.27
2. Godfrey roasters		0.22
3. Calcine handling		0.05
4. Kitchen pulling		0.76
5. Arsenic trioxide handling		0.15
6. Metallic arsenic production		0.10
7. Baghouse dust transfer		0.08
	Total	1.63

To estimate baseline Godfrey roaster emissions, it is assumed that 0.1 percent of the arsenic vaporized during the roasting process is discharged into the arsenic plant building as a result of the transfer of hot calcines from the roaster hearth and the leakage of process offgases from openings in the roaster roof. The arsenic plant material balance shows that a total of 2,178 lb/h of arsenic is vaporized in the Godfrey roasters. Multiplying 2,178 lb/h by 0.1 percent, the low-level arsenic emission rate calculated for the Godfrey roasters is 2.18 lb/h.

G.2.2.3 Calcine Handling. In late 1983, ASARCO began start-up of a pneumatic conveyor system to transfer the Godfrey roaster calcines directly to the Herreshoff roasters. This system replaced the belt conveyor system previously used to handle the calcines. To represent baseline calcine handling operations for the estimation of arsenic emissions, it is assumed that the belt conveyor system is used for all calcine handling. The belt conveyor system consists of a covered belt conveyor to an open, inclined belt conveyor that discharges the calcines into a railcar. No ventilation is applied along the belt conveyor system. Therefore, it is assumed that arsenic emissions from the belt conveyor system are uncontrolled.

The arsenic plant material balance shows that a total of 504 lb/h of arsenic is handled inside the arsenic plant during the transfer of the Godfrey roaster calcine to the railcar loading station at the south end of the building. The assumption is that uncontrolled arsenic emissions from calcine handling are 0.1 percent of the arsenic contained in the calcines loaded into the railcars. Multiplying 504 lb/h by 0.1 percent, an uncontrolled emission rate of 0.50 lb/h was calculated.

G.2.2.4 Kitchen Pulling. Arsenic emissions from kitchen pulling were calculated using an emission factor developed by PSAPCA (pages 2-40 and 2-41 of the high-arsenic proposal BID), which is based on the estimate that 0.5 percent of the arsenic processed through the arsenic plant is potentially lost during the kitchen pulling operations, and on an estimate of the capture efficiency achieved by the local ventilation system currently applied. The kitchen pulling operation is ventilated by movable hoods that vent to a baghouse. Based on observations of kitchen pulling operations during the EPA June 1983, smelter inspection, it is EPA's judgment that the hoods are approximately 90 to 95 percent efficient in capturing dust emissions generated during kitchen pulling. Applying the 0.5 percent emission factor for potential emissions to the arsenic rate of 1,523 lb/h reported in the material balance, and assuming that 10 percent of the potential emissions escape capture, the low-level arsenic emission rate due to kitchen pulling is calculated to be 0.76 lb/h.

G.2.2.5 Arsenic Trioxide Handling. The arsenic plant material balance shows that a total of 1,523 lb/h of arsenic is handled during the transfer, barreling, and railcar loading of arsenic trioxide. It is assumed that uncontrolled arsenic emissions from arsenic trioxide handling are 0.1 percent of the total arsenic trioxide shipped from the plant. The arsenic trioxide is transferred inside the arsenic plant building using a combination of enclosed belt and screw conveyors and pneumatic conveying systems. An overall control efficiency of 90 percent is assumed for these controls. Multiplying 1,523 lb/h by 0.1 percent, an uncontrolled emission rate of 1.52 lb/h was calculated. Applying the control efficiency value of 90 percent, a low-level arsenic emission rate of 0.15 lb/h was calculated for arsenic trioxide handling.

G.2.2.6 Metallic Arsenic Production. The arsenic plant material balance shows that the average hourly arsenic input to the metallic arsenic plant is 111 lb/h. Input arsenic is in the form of purchased, refined arsenic trioxide that is manually loaded from barrels into the hoppers of the two metallic arsenic furnaces. The final product is manually removed from the condensers downstream of the furnaces and loaded into barrels for shipment. The material balance shows that the annual average hourly arsenic output of the metallic arsenic plant is 99 lb/h. The EPA based its estimate of low-level arsenic emissions from the metallic arsenic plant on an approximate annual average hourly arsenic throughput of 100 lb/h. Using the same material handling emission and control factors used for other sources in the arsenic plant, low-level arsenic emissions from the metallic arsenic plant were calculated to be 0.10 lb/h.

G.2.2.7 Baghouse Dust Transfer. The arsenic plant material balance shows that the annual average arsenic content of the offgases from the arsenic kitchens and metallic arsenic production facilities is 832 lb/h. To calculate the arsenic plant baghouse dust transfer emission value, it is assumed that total uncontrolled arsenic emissions are 0.1 percent of the arsenic contained in the collected dust. An overall control efficiency of 90 percent is assumed for the baghouse airslide. Based on source test data, an average of 0.33 lb/h is vented from the baghouse. Therefore, a value of 831.7 lb/h was calculated for the amount of collected dust. Multiplying 831.7 lb/h by 0.1 percent, an uncontrolled emission rate of 0.83 lb/h was calculated. Applying the control efficiency value of 90 percent, a low-level arsenic emission rate of 0.08 lb/h was calculated for arsenic plant baghouse dust transfer.

APPENDIX H

SUMMARY OF TEST RESULTS FOR THE ARSENIC PLANT BAGHOUSE AT ASARCO-TACOMA

SUMMARY OF TEST RESULTS FOR THE ARSENIC PLANT BAGHOUSE AT ASARCO-TACOMA

H.1 INTRODUCTION

From September 12 to 29, 1983, EPA performed a series of emission tests at the ASARCO-Tacoma smelter (IV-A-6). The primary objectives of the test program were:

1. To obtain representative arsenic and particulate emission data at the outlet of the No. 1 Cottrell controlling emissions from the No. 2 reverberatory smelting furnace.
2. To obtain representative arsenic emission data at the inlet and outlet of the fabric filter controlling emissions from the arsenic plant. Testing was to be conducted so as to provide arsenic removal efficiency data for this source.
3. To obtain data for evaluation of the accuracy of arsenic results obtained with the ASARCO continuous sampler compared with those obtained with the EPA testing and analytical procedures for inorganic arsenic.
4. To approximate the arsenic removal efficiency of the No. 1 Cottrell.

Sample and analytical procedures were performed by personnel from an EPA contractor (PEDCo Environmental, Inc.), under the supervision of personnel from the EPA Emissions Measurement Branch. Personnel from another EPA Contractor (Pacific Environmental Services, Inc.), under the supervision of personnel from the EPA Industrial Studies Branch, monitored operating conditions of the processes and control devices during the testing.

Due to ASARCO's decision to close the Tacoma copper smelting facilities and continue to operate only the arsenic plant at Tacoma (IV-D-802), only the test results for the arsenic plant baghouse are presented and discussed in this appendix.

H.2 TEST PROTOCOL

Table H-1 presents a summary of the number and type of tests performed in the test program. The actual sequence of test events was different from the sequence shown because of the arsenic plant production schedule during the test period.

Arsenic concentrations and mass emission rates were determined at the inlet and outlet of a fabric filter (baghouse) controlling emissions from the arsenic trioxide (As_2O_3) and metallic arsenic processes. All

Table H-1. SUMMARY OF ARSENIC PLANT BAGHOUSE TEST ACTIVITY

Date (1983)	Test (Sample) ID	Test Location
9-14	ABKI-1	As_2O_3 baghouse inlet
	AABO-1	Baghouse outlet
9-15	ABKI-2	As_2O_3 baghouse inlet
	AABO-2	Baghouse outlet
9-16	ABKI-3	As_2O_3 baghouse inlet
	AABO-3	Baghouse outlet
9-17	ABKI-4	As_2O_3 baghouse inlet
	AABO-4	Baghouse outlet
9-23	ABKI-5	As_2O_3 baghouse inlet
	ABMI-1	Metallic plant baghouse inlet
	AABO-5	Baghouse outlet
	ABKI-6	As_2O_3 baghouse inlet
	ABMI-2	Metallic plant baghouse inlet
	AABO-6	Baghouse outlet
9-24	ABKI-7	As_2O_3 baghouse inlet
	ABMI-3	Metallic plant baghouse inlet
	AABO-7	Baghouse outlet

tests were made by the sampling and analytical procedures outlined in Reference Methods 1 through 5[a] and proposed Reference Method 108[b].

The baghouse controls emissions from two process gas streams; one transports offgases from the As_2O_3 plant and metallic arsenic condensers, and the other transports offgases from the metallic arsenic process. The gases exiting the baghouse are conveyed to the main stack.

Initially, four Method 108 tests were conducted simultaneously at the As_2O_3 plant inlet and the baghouse outlet while the metallic plant was not operating. Once the metallic plant came back on line, Method 108 tests were performed at the As_2O_3 and metallic plant inlets and the baghouse outlet. A total of three Method 108 tests were conducted simultaneously at the three test locations (two inlet and one outlet).

These data were used to characterize arsenic emissions to the main stack and to estimate the arsenic collection efficiency of the baghouse. Process operations were closely monitored during each emission test period, and samples of Godfrey roaster charge material and baghouse hopper catch were collected and analyzed for arsenic content.

Section H.3 presents the results of the test program on the arsenic plant.

H.3 ARSENIC PLANT TEST RESULTS

Tables H-2 and H-3 summarize pertinent sample, flue gas, and analytical data for tests performed at the arsenic plant baghouse.

Initially, four simultaneous tests were conducted at the As_2O_3 (kitchen) inlet and baghouse outlet test locations. During these tests, the metallic arsenic plant was not in operation. For the inlet tests, designated ABKI (ASARCO Baghouse Kitchen Inlet), the volumetric gas flow rate averaged 731 dscm/min (26,000 dscfm) with an average gas temperature of 74°C (165°F) and moisture content of 5.8 percent. The flue gas composition was consistent for each test and showed oxygen, carbon dioxide, and carbon monoxide results of 19.2, 0.45, and 0.0 percent, respectively. Concentrations of SO_2 typically averaged less than 3,000 ppm or less than 0.3 percent of the total sample volume.

The uncontrolled arsenic concentration from the As_2O_3 plant averaged 7,892 mg/dscm (3.44 gr/dscf), and the corresponding mass emission rate was 343 kg/h (757 lb/h). Results from Test ABKI-1 are not included in the group average; results of this test are biased low because of a loss of sample during analysis. For the baghouse outlet tests, designated AABO (ASARCO Arsenic Baghouse Outlet), flow rates averaged 783 dscm/min (27,700 dscfm) with an average gas temperature of 74°C (165°F) and moisture content of 5.3 percent. Average flue gas composition results were identical to those reported for the kitchen inlet tests. Outlet

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[a] 40 CFR 60, Appendix A, Reference Methods 1 through 5, July 1982.

[b] Federal Register, Vol. 48, No. 140, July 20, 1983, p. 33166-33177.

Table H-2. SUMMARY OF ARSENIC PLANT BAGHOUSE SAMPLE AND FLUE GAS DATA

Run No.	Sample location	Date (1983)	Sampling period	Sampling time, min	Sample volume[a]		Percent isokinetic, %	Volumetric flow rate[b]				Temperature		Moisture, %	Gas composition[d], %			Concentration of SO_2, ppm by volume[e]
								Actual		Standard								
					dNm^3	dscf		m^3/min	acfm	dNm^3/min	dscfm	°C	°F		O_2	CO_2	CO	
ABKI-1	Kitchen inlet	9/14	1030-1647	342.9	5.75	203.038	102.0	943	33,300	746	26,300	77	170	5.3	19.0	0.6	0.0	3832
AABO-1	Outlet	9/14	1030-1652	360	7.92	279.799	101.4	988	34,900	784	27,700	77	171	5.4	19.3	0.4	0.0	3695
ABKI-2	Kitchen inlet	9/15	1220-1747	176	2.85	100.652	100.1	930	32,800	734	25,900	75	166	5.7[c]	19.2	0.4	0.0	3855
AABO-2	Outlet	9/15	1220-1838	360	7.60	268.350	97.9	975	34,400	779	27,500	74	165	5.6	19.2	0.5	0.0	3421
ABKI-3	Kitchen inlet	9/16	0921-1447	176	2.90	102.340	102.6	944	33,300	728	25,700	78	173	6.7	19.2	0.3	0.0	4826
AABO-3	Outlet	9/16	0921-1540	360	7.50	265.041	98.1	977	34,500	768	27,100	78	172	5.8	19.2	0.4	0.0	4387
ABKI-4	Kitchen inlet	9/17	0908-1435	176	2.80	99.053	101.2	876	30,900	714	25,200	65	149	5.3	19.2	0.5	0.0	2847
AABO-4	Outlet	9/17	0908-1540	360	7.72	272.758	96.6	971	34,300	802	28,300	66	152	4.4	19.2	0.6	0.0	2292
ABKI	Kitchen inlet	Average			-	-	-	923	32,600	731	25,800	74	165	5.8	19.2	0.5	0.0	3861
AABO	Outlet	Average			-	-	-	978	34,500	783	27,600	74	165	5.3	19.2	0.5	0.0	3477

Table H-2. SUMMARY OF ARSENIC PLANT BAGHOUSE SAMPLE AND FLUE GAS DATA (Concluded)

Run No.	Sample location	Date (1983)	Sampling period	Sampling time, min	Sample volume[a]		Percent isokinetic, %	Volumetric flow rate[b]				Temperature		Moisture, %	Gas composition[d], %			Concentration of SO_2, ppm by volume[e]
								Actual		Standard								
					dNm³	dscf		m³/min	acfm	dNm³/min	dscfm	°C	°F		O_2	CO_2	CO	
ABKI-5	Kitchen inlet	9/23	0945-1308	176	1.860	65.676	100.8	554	19,500	476	16,800	48	118	5.2	19.2	0.6	0.0	2525
ABMI-1	Metallic inlet	9/23	0945-1310	180	1.366	48.254	104.6	243	8,600	153	5,400	177	350	3.4	19.0	1.0	0.0	245
AABO-5	Outlet	9/23	0945-1310	180	4.112	145.202	97.8	1072	37,900	841	29,700	79	174	5.3	19.0	0.8	0.0	2481
ABKI-6	Kitchen inlet	9/23	1524-1842	176	1.855	65.507	100.3	569	20,100	477	16,800	55	131	5.5	19.2	0.6	0.0	2261
ABMI-2	Metallic inlet	9/23	1525-1845	180	1.848	65.264	101.2	230	8,100	147	5,200	172	341	3.2	19.0	1.0	0.0	72
AABO-6	Outlet	9/23	1525-1845	180	3.947	139.392	98.2	1044	36,900	807	28,500	86	186	5.0	19.4	0.6	0.0	1749
ABKI-7	Kitchen inlet	9/24	1005-1324	176	1.927	68.037	100.6	567	20,000	494	17,400	44	110	5.5	19.0	0.6	0.0	2262
ABMI-3	Metallic inlet	9/24	1005-1326	180	2.027	71.587	103.3	240	8,500	157	5,600	168	335	2.3	19.2	0.6	0.0	66
AABO-7	Outlet	9/24	0950-1326	180	4.154	146.385	99.0	1040	36,700	840	29,700	74	166	4.5	18.9	0.8	0.0	1811
Inlet Average	Metallic							238	8,400	152	5,400	172	342	3.0	19.0	0.9	0.0	128
	Kitchen							563	19,900	482	17,000	49	120	5.4	19.1	0.6	0.0	2350
Outlet	Average				-	-	-	1052	37,200	829	29,300	80	175	4.9	19.1	0.7	0.0	2014

[a] Metered volume corrected for sulfur dioxide content in gas stream and expressed as dry normal cubic meters and dry standard cubic feet. Standard conditions are 760 mmHg and 20°C (29.92 in.Hg and 68°F). The SO_2 content of the flue gas stream averaged less than 0.4 percent of the total sample volume.

[b] Volumetric flow rate expressed in cubic meters per minute and cubic feet per minute at stack conditions. Flow rates corrected to standard conditions are expressed as dry normal cubic meters per minute and dry standard cubic feet per minute.

[c] For ABKI-2 the measured outlet moisture content was used in calculating the stack gas molecular weight and velocity and is not included in the average moisture value for the inlet tests.

[d] Flue gas composition determined by collecting an integrated bag sample and analyzing for oxygen, carbon dioxide, and carbon monoxide with an Orsat Gas Analyzer. Reported carbon dioxide results have been corrected for SO_2 content.

[e] Concentration of sulfur dioxide in parts per million by volume.

Table H-3. SUMMARY OF ARSENIC PLANT EMISSION DATA

Run No.	Date (1983)	Arsenic kitchen inlet				Metallic arsenic inlet				Total inlet				Baghouse outlet				Arsenic removal effi- ciency[b], %	Arsenic[c] removal efficiency % adjusted
		Total arsenic[a]				Total arsenic				Total arsenic				Total arsenic					
		Concentration		Emission rate		Concentration		Emission rate		Concentration		Emission rate		Concentration		Emission rate			
		mg/dNm³	gr/dscf	kg/h	lb/h	mg/dNm³	gr/dscf	kg/h	lb/h	mg/dNm³	gr/dscf	kg/h	lb/h	mg/dNm³	gr/dscf	kg/h	lb/h		
1	9/14	3376[c]	1.48[c]	151[c]	333[c]	-	-	-	-	3376[c]	1.48[c]	151[c]	333[c]	4.28	0.0019	0.20	0.44	99.8	-
2	9/15	7951	3.46	349	770	-	-	-	-	7951	3.47	349	770	3.59	0.0016	0.17	0.37	99.95	-
3	9/16	8636	3.78	378	833	-	-	-	-	8636	3.78	378	833	2.85	0.0012	0.13	0.29	99.97	-
4	9/17	7089	3.08	303	667	-	-	-	-	7089	3.08	302	667	1.88	0.0008	0.09	0.20	99.97	-
Average		7892	3.44	343	748	-	-	-	-	7892	3.44	343	757	3.15	0.0014	0.15	0.33	99.96	-
5	9/23	694	0.30	20	44	33.3	0.015	0.31	0.67	-	-	20.3	44.7	2.48	0.0011	0.13	0.28	99.4	99.6
6	9/23	1520	0.66	44	96	35.5	0.016	0.31	0.69	-	-	44.3	96.7	5.15	0.0023	0.25	0.55	99.4	99.6
7	9/24	889	0.39	26	58	19.7	0.009	0.19	0.41	-	-	26.2	58.4	1.85	0.0008	0.09	0.21	99.6	99.7
Average		1035	0.45	30	66	29.5	0.013	0.27	0.59	-	-	30.3	66.6	3.16	0.0014	0.15	0.35	99.5	99.6

[a] Total arsenic (filterable and gaseous fractions) determined using sample and analytical procedures described in Proposed EPA Method 108. Concentrations are expressed in milligrams per dry normal cubic meter and grains per dry standard cubic foot. Mass emission rates are expressed in kilograms per hour and pounds per hour.

[b] The arsenic collection efficiency of the baghouse was calculated using inlet and outlet mass emission rate data.

[c] Calculation of the adjusted arsenic collection efficiency of the baghouse was based on the outlet mass emission rate and an adjusted inlet mass rate, assuming that all unmeasured flow was equal in concentration to the kitchen inlet. The adjusted inlet mass rates

Run 5: 64.3 lb/h
Run 6: 133.8 lb/h
Run 7: 80.7 lb/h

[d] Some sample fraction lost during analysis and reported results are biased low. Results from Run 1 (kitchen inlet) are not included in the group average.

arsenic concentrations and mass emission rates averaged 3.15 mg/dscm (0.0014 gr/dscf) and 0.15 kg/h (0.33 lb/h), respectively.

Based on mass emission rate results from this group of tests, the arsenic collection efficiency of the baghouse was greater than 99.9 percent. Volumetric flows, temperatures, moisture contents, and SO_2 concentrations measured at each location were comparable.

When the metallic arsenic plant began operation, the same test sequence was repeated and simultaneous tests were conducted at three test locations--the kitchen inlet, the metallic plant inlet, and the baghouse outlet. At the completion of the first set of simultaneous tests (ABKI-5, ABMI-1, and AABO-5), preliminary calculations showed a flow imbalance between the inlet and outlet test locations. The cumulative inlet volumetric flow was 629 dscm/min (22,200 dscfm) compared with an outlet flow of 841 dscm/min (29,700 dscfm). The 7,000-dscfm flow imbalance was attributed to an open flow control damper located in a bypass duct, which entered the metallic arsenic plant exhaust duct downstream of both the metallic and kitchen inlet test locations (see Figure H-1). This condition did not exist during the first series of runs because a second flow control damper located in the metallic plant duct downstream at the bypass duct was closed. The flow imbalance occurred when this second damper was opened. The negative pressure associated with the control system served to divert a part of the flow from the kitchen through the bypass duct and into the baghouse, where it was ultimately measured at the outlet test location.

In addition to the flow imbalance, the arsenic concentration and mass flow rate measured at the As_2O_3 inlet test location were significantly less than that measured during the first set of tests (0.45 gr/dscf and 66 lb/h versus 3.44 gr/dscf and 748 lb/h). No conclusive explanation can be found to account for the significant difference in As_2O_3 plant loading. The arsenic concentration and mass emission rate at the baghouse outlet averaged 3.17 mg/dscm (0.0014 gr/dscf) and 0.15 kg/h (0.35 lb/h). These values are essentially identical to those measured during the first test series, when only the As_2O_3 plant was being operated.

Since a malfunctioning flow control damper made the inlet mass emission rate suspect, the arsenic collection efficiency of the baghouse was recalculated with an adjusted arsenic inlet mass rate for each run. Results were adjusted by assuming that the flow imbalance was diverted to As_2O_3 gas. The flow difference was assumed to have the same concentration as the kitchen inlet and was added to the total inlet mass rate. The arsenic collection efficiency averaged 99.5 percent with both arsenic processes in operation without a calculation adjustment, and 99.6 percent with an adjustment.

Table H-4 summarizes arsenic analytical results for Godfrey roaster charge and baghouse dust samples collected by ASARCO during each test.

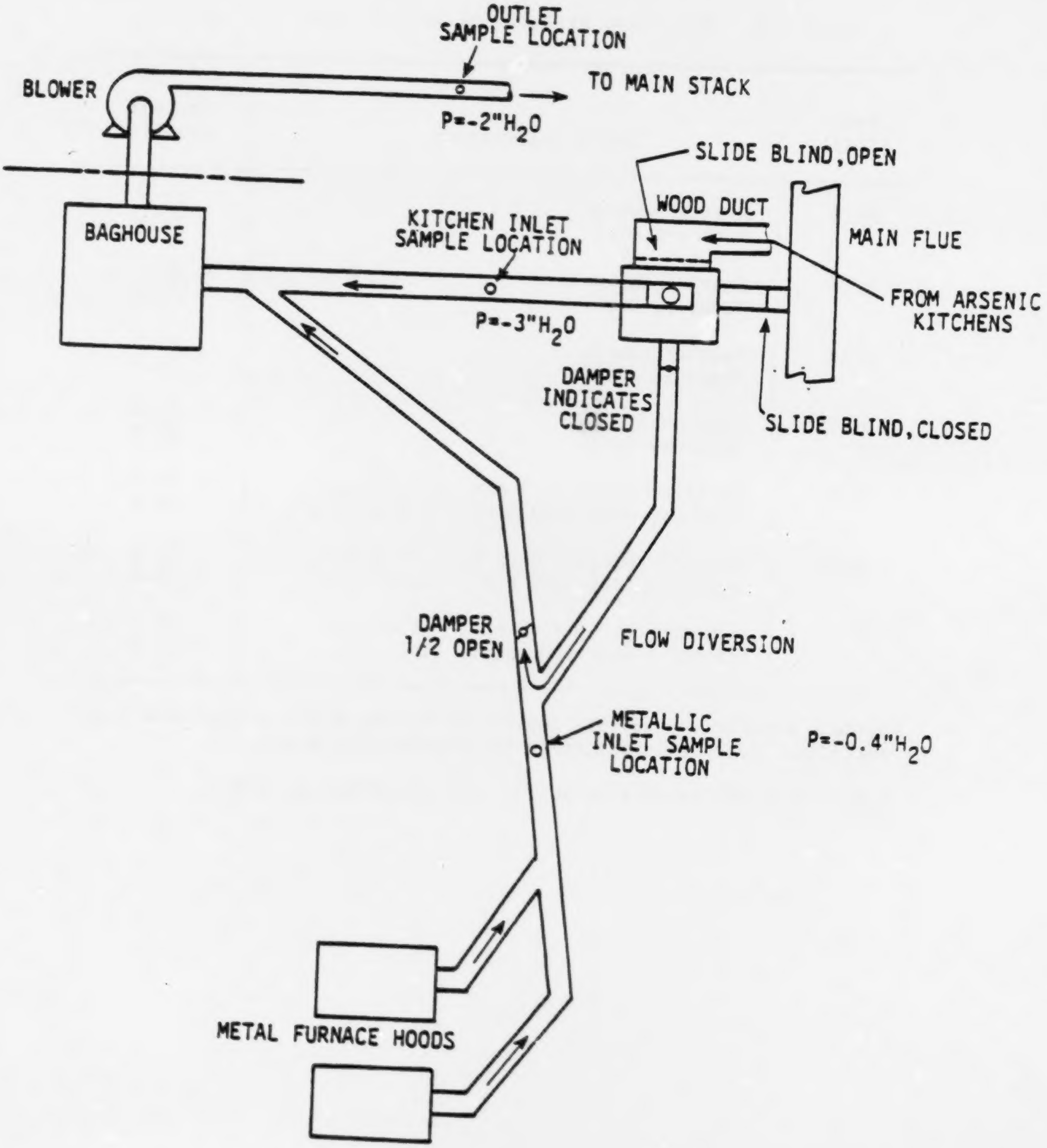

Figure H-1 Arsenic Plant Gas Flow Schematic -- ASARCO-TACOMA

Table H-4. ANALYTICAL RESULTS FOR ARSENIC PLANT TEST SAMPLES

Date (1983)	Sample description	Percent Arsenic[a]
9/14	Roaster charge	37.2
	Baghouse dust	74.5
9/15	Roaster charge	27.8
	Baghouse dust	73.5
9/16	Roaster charge	25.3
	Baghouse dust	75.2
9/17	Roaster charge	32.2
	Baghouse dust	67.7
9/23	Roaster charge 7:00 a.m. - 3:00 p.m.	33.2
	Baghouse dust 7:00 a.m. - 3:00 p.m.	75.8
9/23	Roaster charge 3:00 p.m. - 11:00 p.m.	61.6
	Baghouse dust 3:00 p.m. - 11:00 p.m.	72.8
9/24	Roaster charge 7:00 a.m. - 3:00 p.m.	47.1
	Baghouse dust 7:00 a.m. - 3:00 p.m.	71.8

[a] Percent arsenic (by weight) determined by the sample preparation and analytical techniques described in proposed EPA Method 108.

Note: All samples were collected and identified by ASARCO.

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(Please read Instructions on the reverse before completing)

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

National emission standards to control air emissions of inorganic arsenic from new and existing primary copper smelters and from arsenic trioxide and metallic arsenic production facilities are being promulgated under Section 112 of the Clean Air Act. Part I of this document contains a detailed summary of the public comments on the proposed standard for primary copper smelters (48 FR 33112), and Part II on the proposed standard for arsenic production facilities (48 FR 55880). The document also contains Agency responses to these comments and a summary of the changes made to the standards between proposal and promulgation.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Hazardous air pollutant Pollutant control Standards of performance Inorganic arsenic Primary copper smelters	Air Pollution Stationary sources	13 B

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